## Contents

List of contributors viii
Preface xviii

The geographies of innovations: beyond one-size-fits-all 1
*Richard Shearmur, Christophe Carrincazeaux and David Doloreux*

### PART I  THEORETICAL APPROACHES AND CONCEPTS

**Part I  Introduction**  
*Richard Shearmur, Christophe Carrincazeaux and David Doloreux*

1 Regional innovation, R&D and knowledge spillovers: the role played by geographical and non-geographical factors 22  
*Philip McCann and Raquel Ortega-Argilés*

2 Regional innovation systems: past – present – future 45  
*Björn T. Asheim, Markus Grillitsch and Michaela Trippl*

3 Understanding and learning from an evolving geography of innovation 63  
*Andrés Rodríguez-Pose and Callum Wilkie*

4 The cultural embeddedness of regional innovation: a Bourdieuan perspective 88  
*Ben Spigel*

5 Proximity dynamics and the geography of innovation: diminishing returns or renewal? 100  
*Marie Ferru and Alain Rallet*

### PART II  RELATEDNESS AND KNOWLEDGE BASES

**Part II  Introduction**  
*Richard Shearmur, Christophe Carrincazeaux and David Doloreux*

6 Relatedness and the geography of innovation 127  
*Pierre-Alexandre Balland*

7 How do firms acquire knowledge in different sectoral and regional contexts? 142  
*Franz Tödtling and Michaela Trippl*

8 Clusters initiatives, open innovation and knowledge bases 155  
*Heidi Wiig Aslesen and Arne Isaksen*
# Handbook on the Geographies of Innovation

## Part III Cities, Innovation and Creativity

### Part III Introduction

*Richard Shearmur, Christophe Carrincazeaux and David Doloreux*

9 Innovation and creativity in city-regions  
*David A. Wolfe*  
174

10 Intelligent cities and the evolution toward technology-enhanced, global and user-driven territorial systems of innovation  
*Nicos Komninos*  
187

11 Geography, skills and career patterns at the boundary of creativity and innovation: digital technology and creative arts graduates in the UK  
*Roberta Comunian, Alessandra Faggian and Sarah Jewell*  
201

## Part IV Beyond Agglomeration and Clusters

### Part IV Introduction

*Richard Shearmur, Christophe Carrincazeaux and David Doloreux*

12 Four commonly held beliefs about the geography of scientific activities  
*Michel Grossetti, Denis Eckert, Marion Maisonobe and Josselin Tallec*  
223

13 Putting the boot into creative cluster theory  
*Chris Gibson and Chris Brennan-Horley*  
241

14 Beyond networks in clusters  
*Franz Huber and Rune Dahl Fitjar*  
255

15 Suburban creativity and innovation  
*Alison Bain*  
266

16 Innovation in peripheral regions  
*Arne Isaksen and James Karlsen*  
277

## Part V Innovation Policy

### Part V Introduction

*Richard Shearmur, Christophe Carrincazeaux and David Doloreux*

17 Regional economic development: institutions, innovation and policy  
*Neil Bradford and Allison Bramwell*  
292

18 Revisiting the role of policy in regional innovation systems  
*Elvira Uyarra and Kieron Flanagan*  
309

19 Evolution of regional innovation systems in China: insights from emerging indigenous innovation in Shenzhen  
*Chun Yang*  
322
20 Entrepreneurial regions in theory and policy practice

*Helen Lawton Smith*

### PART VI TRANSGLOBAL MOBILITY AND NETWORKS

**Part VI** Introduction

*Richard Shearmur, Christophe Carrincazeaux and David Doloreux*

21 The Internet: its geography, growth and the creation of (digital) social capital

*Emmanouil Tranos*

22 The geography and structure of global innovation networks: global scope and regional embeddedness

*Cristina Chaminade, Claudia De Fuentes, Gouya Harirchi and Monica Plechero*

23 Migration and innovation: a survey of recent studies

*Stefano Breschi, Francesco Lissoni and Claudia Noumedem Temgoua*

24 The geography of innovation in multinational companies: internal distribution and external embeddedness

*Jannika Mattes*

### PART VII LOCAL IMPACTS OF INNOVATION

**Part VII** Introduction

*Richard Shearmur, Christophe Carrincazeaux and David Doloreux*

25 Growth with inequality? The local consequences of innovation and creativity

*Neil Lee*

26 Why local development and local innovation are not the same thing: the uneven geographic distribution of innovation-related development

*Richard Shearmur*

27 Cultural creation and social innovation as the basis for building a cohesive city

*Juan-Luis Klein and Diane-Gabrielle Tremblay*

*Index*
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Handbook on the geographies of innovation

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Preface

When we were approached to edit this *Handbook on the Geographies of Innovation* our first reaction was that there are already many similar volumes out there. However, on second thought, we saw this as an opportunity to explore some of the more recent and exciting ideas about the geography of innovation, ideas that question the paradigm established in the 1980s and which still structures much of the discourse about innovation and its geography today.

Indeed, the selection of chapters and authors in this book stems from our feeling that there has been lock-in within the ‘geography of innovation’ community, and there may therefore be a need for path renewal. Seminal work of the 1980s – emerging in a time of industrial crisis, in the pre-internet age, and in an era of only hesitant globalization and neoliberalization – is still shaping the way we think about innovation, regions, proximity and knowledge flows today. Many of the same eminent scholars who developed these ideas are still actively involved in developing and promoting them, and have trained a new generation of scholars who are refining and extending them. These ideas – many of which focus on regions, local interactions, clusters, and which situate the prerogative to innovate in a context of global competition between national economies – remain valid today and are represented in this collection. The ideas are being modified and extended incrementally, and are becoming more complex and nuanced.

However, their dominance has tended to stifle alternative views of the geography of innovation, of its purpose (rarely questioned), and indeed of its local and global impacts (rarely considered beyond the fact that it is believed to increase global productivity). Many of today’s dominant ideas have been developed in a Western, indeed in a North European, context, and have been imported somewhat uncritically into different geographic contexts such as Canada, Australia (which remain Western), India and China. They have also been applied to sparse regions and suburban localities where alternative views of how firms innovate, how knowledge is acquired, and what the purpose of innovation is are necessary. Finally, they have not always taken into account new ways of conceptualizing geographic space (such as that articulated by Doreen Massey in her 2005 book *For Space*), nor the problematic concepts of ‘region’ and ‘location’, which are becoming increasingly fuzzy as individuals, communities and firms become more mobile (across diverse distances and timescales) and interconnected.

The chapters that have been selected should be seen as an unrepresentative sample of some of the more established views and approaches to the geography of innovation, and of some of the newer and more unorthodox ones. We recognize that the volume remains oriented towards a Western (or Global North) perspective, and we can only hope that the new ideas and processes that are being developed and observed in other parts of the world will also gain a wider audience and provoke debate and reflection about the role of, reason for and geographic patterns of innovation. Our inability to reach much beyond Western (or Global North) scholars with respect to chapters in this volume reflects the limits of our networks, and the fact that even in a world of global connectedness culture,
language and distance continue to play a role in the creation, exchange and diffusion of ideas.

We hope that the juxtaposition of chapters in this volume will lead to debate and dialogue between scholars – that those more embedded in prevailing paradigms will consider some of the newer arguments, and that those forging ahead with new ideas and observations will take stock of the important knowledge and understanding of the geographies of innovation that have been built up since the 1980s. If there is to be path renewal in our understanding of the geographies of innovation, such open dialogue and mutual acknowledgement and respect for both established and more recent ideas and empirical work are a prerequisite.

We are very grateful to all the authors who have contributed their time and expertise to this volume. We are also grateful to our colleagues and families for allowing us the time to work on this collection: whilst editing a handbook has a more managerial flavour than writing a monograph, the time and effort involved are not dissimilar. Finally, we would like to thank the editors at Edward Elgar, Matthew Pitman in particular, for having entrusted us with this project and for having supported us during the process.

Richard Shearmur, Christophe Carrincazeaux and David Doloreux
The geographies of innovations: beyond one-size-fits-all

Richard Shearmur, Christophe Carrincazeaux and David Doloreux

INTRODUCTION

‘Geographies of Innovations’, an ideal title for this Handbook since it problematizes both geography and innovation, does not trip off the tongue as easily as ‘Geographies of Innovation’, yet using the singular of either word perpetuates some of the lock-ins that this collection of chapters hopes to shift. Notwithstanding the cutting-edge work being undertaken by many scholars – some of whom are represented in this collection, many of whom are not – a number of truths about the geography of innovation seem to be universally acknowledged, at least beyond the confines of acade. Some examples of accepted truths are: that innovation occurs more easily in certain places – such as large cities and (high-tech) clusters; that creativity (and creative people) is the key driving force of innovation; that economic growth and social development rest upon innovation; that innovation can (easily) be measured by indicators such as patents; that there is agreement over what innovation is and why it is studied and so on. Of course, none of these stylized facts is inherently false, but none is inherently true – the context (geography being but one type of context) within which they are applicable and to which they apply requires careful thought, and innovations occurring in different contexts, following different processes or with different (welfare-decreasing? unequal?) outcomes also need to be taken seriously.

Indeed, early research in the field of the geography of innovation – which we distinguish from work on innovation and information diffusion such as Pred (1973) and Rogers (1962) – focused on the importance of geographical co-location and concentration of actors as catalysts for firm innovation activities. Innovation was conceptualized as a process grounded in proximity relations, in favourable conditions for interaction, and in learning focused on the exploration of new knowledge combinations and opportunities (Doloreux, 2002; Cooke et al., 2004; Asheim and Gertler, 2005). Geographic proximity and spatial concentration were thought to stimulate interactive learning capacities by facilitating the relations between innovating businesses and the external factors needed for the innovation process. Given these assumptions, many of which gained traction in the 1980s and 1990s based upon empirical observation of innovative regions that successfully weathered the structural changes (industrial decline and the beginnings of globalization) of the period, innovation was conceptualized as the result of complex, non-linear, social processes that are territorially embedded. It should be recalled that until the early 1990s the internet was the preserve of defence departments, universities and a few large corporations, transatlantic telephone calls cost over 50 cents a minute, and mobile phones were the size and weight of bricks (with about as much signal coverage). Geographic
proximity and regions, understandably, played a key role in enabling collaboration and information exchange.

There is, however, increasing discomfort with existing paradigms and stylized facts that organize the conceptualization of innovation’s geography, discomfort that is by no means restricted to the editors of this *Handbook*, as many of the chapters make clear. An increasing body of work has been gathering momentum since the early 2000s as a new generation of researchers (for whom the 1980s recession and the success of certain innovative districts is a hazy background to childhood or teenage years, and for whom adulthood without mobile phones, internet, cheap and instantaneous communications and frequent international travel is unknown) has questioned these accepted truths. They have proposed new approaches, and have undertaken studies on the ways geography could explain (or not) innovation, critiquing the early literature for relying too much—often exclusively—on local and regional explanatory factors. Some examples of this are Bathelt et al.’s (2004) emphasis on the role of pipelines, that is, connections between innovative clusters; Bathelt’s more recent work on temporary contacts and fairs (Bathelt, 2011), in line with questions raised by the French School of Proximity (Ferru and Rallet, Chapter 5, this volume; Carrincazeaux and Coris, 2011); Huber’s (2012) questioning of the internal dynamics of clusters; Petrov’s (2011) work on innovation in the remotest parts of northern Canada; Lee and Rodriguez-Posé’s (2013) work on radical innovation in the UK—which tends to occur outside towns; Grillitsch and Nilsson’s (2015) work on innovation in remote parts of Sweden; Gibson’s (2008) work on creativity in remote Australia; Shearmur and Doloreux’s (2015) work on innovation in peripheral areas and on the role of distance to a metropolitan area, empirically exploring some of McCann’s (2007) theoretical predictions; Bain’s (2013) studies of innovation and creativity in non-descript metropolitan suburbs; Jeannerat and Crevoisier’s (2016) work on territorial value-creation through cultural innovation and local story-telling; Rutten’s (2016) new conceptualizations of the socio-spatial dynamics of knowledge creation; Ndabeni et al.’s (2016) questioning of the relevance of ideas derived from the global North in other contexts and so on. This list is far from exhaustive: its purpose is to establish that the geography of innovation, and of its necessary precursor, creativity, is by no means limited to the idea that agglomeration, information spillovers, localized knowledge bases and urban diversity are the key geographic factors that underpin them.

If so much has already been written that nuances where and how innovation processes play out across space, what, then, is the problem? In our view, this recent proliferation of ideas and empirical work, which all question some central assumptions that underpin the mainstream economic geography of innovation (see McCann and Ortega-Argilés, Chapter 1, this volume), has not yet established a new paradigm (something which is probably neither necessary nor desirable), nor has it overcome the inertia of better-established and still-dominant ideas (which this *Handbook* will hopefully contribute to overcoming), ideas that influence policy-making even if their hold on academia is eroding. Of course, it would be counterproductive to dismiss the important work that has been done since the 1980s on milieu, clusters, knowledge spillovers, local institutions and innovation systems. Likewise, it is counterproductive to cling to ideas and concepts merely because they are highly cited and authoritative, something that older ideas will be, by definition. The chapters in this collection are a mixture of classic ideas and approaches that have evolved and take into account new phenomena and theories, of
newer approaches that are seeking to make sense of innovation’s geographies in a world of mobility, globalization and communication, and of attempts to theorize some of these new phenomena.

As well as these wider considerations, a specific motivation has driven this Handbook: dissatisfaction with the way geography has been mobilized and conceptualized by students of innovation. Quite often, ‘geography’ is implicitly reduced to distance (or its inverse, physical proximity) or to region (that is, a bounded zone on a map or an administrative entity) – with observations classified opportunistically on the basis of the geographic coding of the data at hand. The idea of theorizing geography, the idea that geography can be more than a backdrop for the more serious work of conceptualizing innovation, economic processes and the firm, is often neglected. Failure to make explicit the geographic assumptions implied by the choice of metric, matrix, spatial unit or geo-localization method has not only short-changed the complexity of the geographies of innovation, it may also have short-changed the ways in which innovation itself is understood. For instance, because most databases that record innovation are not geographically representative (Eurostat, 2014), or tend towards an urban bias (Shearmur, 2012), then many innovation processes deemed universal are in fact specifically urban (non-urban observations being swamped by urban observations): this may not be problematic to students of industry and global innovation processes – after all, the majority of economic activity takes place in cities – but is crippling to understanding the geography of innovation because innovation processes occurring in non-urban places are simply ignored or, if acknowledged, considered as anomalies.

The chapters in this book provide a good overview of existing paradigms, critiques and possible alternatives to the geography of innovation: they evoke a variety of geographies of innovation. In this introductory chapter, we first discuss various different ways of conceptualizing geographic space. This discussion cannot be exhaustive, but is intended to provide a pallet of conceptualizations, each of which can shed different light on innovation processes. We then briefly discuss different types of innovation, and different motivations for studying innovation, which impact upon the way geography is mobilized. We propose a list of six ‘confusions’ that make reading and understanding the wide literature on the geography of innovation problematic, and that can serve as keys to reading the chapters in this book and other work on the subject. We conclude this chapter by providing a brief overview of the structure of the book.

GEOGRAPHIC CONCEPTS AND THE STUDY OF INNOVATION

In this section, we provide a succinct overview of a variety of geographic concepts that are often left implicit in the study of innovation: in the same way that innovation needs to be conceptualized and has been the subject of many discussions so too, we suggest, should geography. The first subsection discusses some of the concepts that structure the study of innovation’s geography (that is, of where innovation occurs). The second subsection draws attention to an alternative way of considering the geography of innovation – the geography of geographic concepts themselves.
The Geography of Innovation: Problematizing Geographic Concepts

Two apparently straightforward concepts have structured the study of innovation’s geography, the first of which is the region. This generic term usually refers to a physical space, with borders that can be drawn on a map – an actor (an establishment, for example) is either in or out of the region. Thus, for example, NUTS 2 regions in Europe, counties in the USA or, at different scales, municipalities or metropolitan areas are all treated as regions with actors located within or outside them.

Regions, however, are complex and intractable – only becoming tractable at the expense of simplification or abstraction. Their complexity resides not in the way they are coded – it is possible for anyone to pick up data and look at the regional codes – but in the concepts that underpin regional taxonomies. Some regions are essentially administrative: municipalities, for instance, have tended to emerge (at least in North America) from the desire of local populations to incorporate and manage the land upon which they rely. Counties and states reflect, depending on the jurisdiction, a central authority’s attempt to rationalize and bound the sphere over which it exerts power (the French départements, for instance) or the outcome of negotiations between a federal authority and more localized powers (US states and German Länder, for instance) (Elden, 2013). Thus, when Eurostat codes data at the NUTS 2 level, and when researchers use this classification, they are adopting without question a spatial taxonomy that has emerged over time, that reflects different national, and local, histories and political logics and that has little or no economic significance.

In recognition of this problem, regions have been defined and studied from a functional perspective (Andersson and Karlsson, 2006). Whilst actors are still classified as being ‘inside’ or ‘outside’ the region, an attempt is made to define a geographic area within which economic functions are contained. Functional regions, whilst they address problems inherent in using administrative boundaries, remain blunt instruments for understanding spatial dimensions of the economy. The extent and limits of a functional region depend upon the function being observed. Commuting patterns are commonly used to classify municipalities or counties into labour market areas, and the geographic extent of a cluster – central to much of the work on innovation – is also defined in a similar way, that is, as the area within which related firms interact intensively (Rosenfeld, 1997). This approach only defines a region along one dimension: commuter flows or interactions may be (almost) internalized, but what about information flows, flows of goods, retail market areas? There are maybe as many functional regions or clusters as there are functions or types of interaction (Uyarra and Flanagan, Chapter 18, this volume).

This leads us to consider what is meant by a region’s border. At one level, the question is administrative: a region’s border is what the state or government says it is. This definition can be necessary if one is studying politics and policy – particularly if policies are applied within administrative borders (Bradford and Bramwell, Chapter 17; Lawton Smith, Chapter 20, this volume). At other levels, though, the region’s borders are problematic and inherently fuzzy. The extent of labour market areas and clusters rest upon arbitrary thresholds, above or below which a spatial unit or agent is not considered to be in the area. So not only can functional areas vary depending on the choices made by the researchers, any particular spatial unit may be attached to numerous functional regions, and functional regions (even when defined on the basis of a single function) can...
overlap. Another problem is that functional regions usually presume spatial contiguity and stability over time. However, there is nothing inherent in the idea of firm interactions or commutes (for instance) that dictates that only spatial units and agents contiguous to the cluster’s core will be strongly linked to it: unless an arbitrary contiguity criterion is imposed on functional regions, these regions may rapidly begin to look like a moth-eaten blanket. Furthermore, functions evolve over time, sometimes quite quickly: the closure of one establishment may reconfigure flows in such a way that spatial units fall in (or out) of different functional regions (Mattes, Chapter 24, this volume).

A concept related to – but distinct from – functional regions is that of territory. As used in the francophone literature (for example, Campagne and Pecqueur, 2014) a territory is an imagined region, a space to which people feel attached and in which there is a shared identity. This type of region can be constructed over time as local social networks evolve, informal institutions develop and local identity is created. This sociological view of regions faces problems similar to the functional view since it shares the assumption of a single identity and unique local networks. However, within the same geographic space different actors can have radically different views of what constitutes the territory: some may identify with micro-local spaces (a street corner, a square), others with wider administrative entities (the municipality), whereas others still may evolve in a-spatial communities of practice that can defy any geographic description (Amin and Roberts, 2008).

One of the geographers who has most elegantly described the challenges of conceptualizing geographic space is Doreen Massey (2005). For her, a region does not have fixed borders but is an intersection of processes and people. Each of these processes takes place across time, and involves people each of whom is mobile. This mobility occurs at different spatial scales and timescales: trajectories can be linked to migration, commuting, vacation travel, business travel and so on. At any one moment the region is made up of the people who are there, each of whom is drawing on their past trajectories and upon their cultural, social and business networks that often span the globe or are essentially a-spatial (such as communities of practice). People interact, leading to processes that are both place-based – they occur somewhere and they generate localized dynamics (Rutten, 2016) – and global or a-spatial.

This view of the region, which in many respects generalizes the concept, problematizes the very idea of location. Where is an actor located? Should an inventor be located at his or her home address, even when the inventor travels for many months of the year? Should an establishment be located at a particular business park, even when the people who constitute the establishment travel, or, if they don’t, are connected to actors external to the region via the internet (see Transo, Chapter 21, this volume)? Can one allocate ‘creativity’ to cities (Wolfe, Chapter 9, this volume), when most creative people escape from the city to go hiking, skiing or travelling in order to resource themselves? For students of the geography of innovation, these questions are not merely ancillary to the ‘serious’ questions that surround knowledge creation, technology, growth and clusters, they are at the very core of a central assumption that underpins innovation studies, at least those that explore its geography, viz. that actors in the innovation process can be located, and that the local context within which they evolve can be characterized by the ‘region’ where they are located.

Another question that emerges is that of scale: at what spatial scale do processes, such as knowledge externalities, occur? Assuming that actors do require co-location – a
contentious one as Ferru and Rallet argue (Chapter 5, this volume), at what scale is this co-location necessary? This may differ from actor to actor, from collaboration to collaboration, from process to process and over time within the same process: the idea – common in economic geography – that ‘agglomeration’ is important is problematic from a geographic perspective, even if one elides the question of the nature (dynamic or static, for instance) of the externalities themselves.

This leads to the second broad geographic concept that has underpinned the geography of innovation: distance (Shearmur, 2011). Distance, unlike regions, does not presuppose boundaries and does not require the classification of geographic space or actors as being part of, or external to, a region. The concept does, however, require two basic, and problematic, assumptions. First, as we have already discussed, distance presupposes location: a distance is between two points, or between one point and many. However, the location of an economic actor, mobile across space, and which can – if a firm or an organization – be present in multiple places at once is difficult to ascertain. Second, it supposes a metric of distance. As we discuss below, distance has increasingly been conceived along various dimensions – geographic, cognitive, social and so on – but even if one restricts oneself to geographic distance, the notion is unclear. Indeed, measuring geographic distance is almost impossible unless one first describes why distance is being measured, why one hypothesizes that it is relevant. If its relevance is time, then distance can be measured in minutes, as the time it takes to get from A to B: but this time can change depending on the time of day, on congestion or on how much one is willing to pay. If its relevance is cost, then distance can be measured in dollars: but the cost of covering distance depends, as we have just pointed out, on the method of transport. Of course, distance is often considered relevant because it eases, or hinders, communication and learning: but the way one measures distance, the time during which distance matters, the existence of non-linear (threshold) effects, the complementarity or substitutability of communication technologies and face-to-face all factor into the notion of ‘distance’ between two places.

Thus, when, for example, ‘spillover’ effects are posited, and are thought to be dependent on distance, the way distance is conceptualized and the way actors are geo-localized need to be problematized in order for the mechanism to be understood and for the validity of a given metric to be ascertained. The physical distance between actors will change depending on what aspect of their relationship is being measured, even if the actors remain immobile.

We are not suggesting that researchers have not thought about these questions. It is probable that each researcher could return to his or her research and extract the geographic concepts that underpin it. The problem lies in the fact that these geographic concepts are usually left implicit, are consequences of the data at hand or of the simplest way of observing things rather than problematized as part of the study. Whereas innovation processes have been thought about, theorized and their consequences integrated into our thinking about the geography of innovation, geography itself has tended to be an afterthought. As a consequence, we in fact know rather little about the way in which innovation processes change across space, the way in which spatialized and non-spatialized processes interact or whether these are complements or substitutes. Likewise, even if one accepts that local context influences innovation dynamics, the way in which this context is conceptualized and the ‘local’ defined remain vague.
There is another way of considering the geography of innovation, one that may contribute – at least partly – to explaining differences of view, of emphasis and of empirical results. Geographers, economists and other scholars of innovation are themselves situated (Schoenberger, 2007; Ndabeni et al., 2016). They often observe what is around them, have access to local data and bring to bear on their understanding of geography their own personal experiences. Thus, for instance, the idea of territory – of small regions that share history and culture from which it is assumed that identity can be constructed – may reflect a (romanticized?) European experience, one of French terroirs and Swiss cantons that have traditionally housed close-knit communities. In a context where such geographic concepts strongly permeate the imaginary, it is easier to look at economic processes and see local structures – maybe at the expense of wider global or a-spatial ones.

Conversely, ideas of distance and remoteness, and the notion that attachment to particular places is contingent on local opportunities, permeate North American culture: they not only furnish the imaginary (which is populated by log cabins, lonesome cowboys and Harley Davidsons on the open road), but are also brought home to any researcher who travels beyond metropolitan areas there (Shearmur, 2015). Thus, it is probable that the culture within which researchers have been brought up shades the questions they ask and the priorities they assign to different concepts. This shading is partly a question of cultural imaginaries and perceptions, but also a question of empirical reality: if one can regularly observe firms situated in remote regions over 500 kilometres from a major city (a type of observation that is quite common in Canada and Australia, see Gibson and Brennan-Horley, Chapter 13, this volume) then clearly the concept of territory carries less analytical weight than those of distance and isolation.

Similarly, most chapters in this Handbook assume that innovation is essentially a matter of individual decision-making by entrepreneurs, with policy and institutions acting as facilitators. Location decisions, and the decision of whether to innovate or not, are the preserve of the individual or private company. Yang (Chapter 19, this volume), however, reminds us that in some contexts these assumptions simply do not hold – that, for example, the very notion of ‘cluster’ needs to be reinterpreted when these basic (Westernized) assumptions do not hold. Likewise, researchers studying innovation in South Africa’s periphery, seeking to learn policy lessons from current literature, are discovering that it ‘draws heavily on experiences in the global North . . . [and] . . . that the “cluster” model of economic growth and innovation originated with industrial or technological, city-based clusters in the global North’ (Ndabeni et al., 2016, p. 10). The literature may therefore be of limited direct relevance, and any lessons drawn from it must be handled with caution.

Personal experience – and not only the researcher’s current location – can shade the emphasis that each researcher gives to particular phenomena (Aldridge, 1993). A researcher who has grown up, studied and now works in places all within a few hundred kilometres of each other will probably have a different view of the geography of networks and the role of geographic proximity than a researcher who has migrated a number of times and has family strewn across the globe: it is probable that the lead author’s personal trajectory – born in England, raised in France, living in Canada, with Iranian, English, French and Canadian (in various combinations) daughters, a brother in Kyrgyzstan, one
in Switzerland and various other close relatives dispersed across the globe (some even in England) – may have something to do with his conceptualization of geographic space as a field of opportunities and connections rather than as territories or regions within which interactions occur. And whilst all researchers – the lead author included – strive to overcome such personal experience in order to let data and theory speak ‘objectively’, the fact remains that each researcher will tend to look for and find that with which he or she is more familiar.

Without wishing to over-emphasize this aspect of the geography of innovation, certain ideas and concepts resonate more with some people than others, and this resonance may reflect the local (or non-local) culture and personal experiences of researchers and groups of researchers: the European notions of clusters, territories and regions contrast with the North American, Canadian and Australian notions of space, distance and remoteness. Therefore, one dimension of the geography of innovation that should be considered is the geography of the people who write about the subject (their personal trajectories are rather more difficult to learn about). In this book, the geography of the authors is not as diverse as we would have wished, but one key to reading the collection is to examine the geographic and social contexts from which each chapter emanates.

STUDYING THE GEOGRAPHY OF INNOVATION: SIX CONFUSIONS

Even within the current literature there exist a wide variety of approaches to studying the geography of innovation – indeed, to studying the geographies of innovations. We highlight below six key ambiguities (or confusions) that run through the literature, and also run through the chapters of this book. We use the word ‘confusion’ because these are recurring ambiguities in motivation, conceptualization and interpretation of innovation research that, quite simply, lead to confusion. Secure in their own (completely justified, but often implicit) positions with regards these confusions, researchers will often talk past each other, not recognizing that other (likewise justified and implicit) positions motivate and structure other research.

These confusions speak to the different scales and spatial concepts that are implicit in discussions of the geography of innovation, and also speak to the different ways innovation can be understood (something that has not been fully discussed in this chapter, but that raises conceptual questions as complex as those discussed about geography).

Confusion 1: Innovative Regions or Innovative Entrepreneurs?

One central confusion found in the economic geography literature on innovation is between research that takes as its starting point the region – that is, that entertains the idea that the geography of innovation is the geography of innovative regions – and research that takes as its starting point the entrepreneur – that is, an innovator who may, or may not, be located within an innovative region. These two approaches are rarely clearly distinguished, leading, for example, to the unsubstantiated notion that innovation is the prerogative of clusters and large cities. It is not because some regions are deemed
innovative (by dint of their institutions, culture, high number of patents and so on) that innovative entrepreneurship does not occur outside them (Shearmur, 2012).

This lack of clarity is at the root of the proximity dynamics approach, which developed in France in the 1990s (Ferru and Rallet, Chapter 5, this volume). A twofold critique was developed: first, a methodological one, turning on the fact that if one studies space (or regions), localized interactions will be observed, but may not be relevant to the agents’ innovation process; second, a theoretical one, focusing on the fact that space remains exogenous when it is considered a unit of analysis – which raises the question of geography’s role if it is decided that interactions and institutions are the key units of analysis (Carrincazeaux et al., 2008).

Choosing the unit of analysis (regions or agents and their interactions?) partly depends upon the purpose of study and is partly a methodological decision related to how the role of geography is understood in the innovation process. If the focus is on innovation itself, geography is often reduced to a support generating uneven innovative potential linked to local conditions and barriers to the diffusion of knowledge. Conversely, the regional systems approach seeks to explain this uneven innovative potential as the result of local dynamics and resources (Asheim et al., Chapter 2, this volume), whilst emphasizing the openness of local spatial systems. Some intermediate approaches are beginning to emerge, for example, in the analysis of proximity dynamics (Bouba-Olga et al., 2015) and regional resilience (Boschma, 2015). Yet, the basic confusion remains – is the region or the innovative agent the focus of study?

Confusion 2: The Efficient Geographic Distribution of Innovative Agents in View of System-wide Innovation, or Local Innovation as a Spur for Regional Development?

A second confusion is between studying innovation at a system-wide level (within the European Union or within the USA, for example) and studying innovation as a means to furthering local economic development. This confusion is not entirely distinct from the first one, also raising the question as to why innovation is being studied.

From a Paretian perspective, the economy should be organized to maximize output (which can, theoretically, be redistributed so that everyone benefits). In innovation studies, this translates into the idea that agents of innovation (firms, inventors, research and development (R&D) facilities and so on) should be organized in the most efficient way. The geography of innovation is studied in order to determine the most efficient geographic configuration of these agents, and relates to the spatial configuration of actors and processes that lead to system-wide innovation.

If, however, regional development is of concern – as it is to many geographers and to all local administrations – then the geography of innovation is studied in order to understand how localities can best encourage innovation in local firms, and, if possible, retain the benefits of this innovation. The focus is on the nature of local factors that can attract, retain or stimulate innovators, in the hope that this will lead to local development.

These two fundamentally different approaches to the geography of innovation – one operating on the assumption that system-wide innovation should be ‘maximized’, the other operating on the assumption that localized innovation should be encouraged so that its benefits are geographically distributed (see Shearmur, Chapter 26, this volume) – are rarely clearly distinguished. Each may reflect particular disciplinary epistemologies,
with geographers tending more towards the study of innovation as a localized process that can have local outcomes, and economists towards the search for efficient spatial distribution. The two become confused, however, when innovation policy is considered since the distinction is politically unpalatable: whilst national governments implement innovation policy (including its spatial dimension) in view of maximizing system-wide efficiency, political mileage can be made by appealing to the idea that local innovation agents will foster local development.

Confusion 3: World First Innovations versus Small-scale Entrepreneurial Innovation

A third confusion is between the study of world first, highly visible and well-marketed innovations and the study of small-scale incremental innovation that is a prerequisite of firm adaptation and survival. Indeed, studies that focus on the former will tend to identify large cities and clusters as the source of innovation, not always distinguishing the market power of institutions and companies located there from innovation itself. The study of smaller-scale innovations and innovation in small and medium-sized enterprises (SMEs) – innovations that can sometimes flourish into larger-scale innovation, often after the innovator has moved to a large city or been bought up (see Shearmur, Chapter 26, this volume; Livi and Jeannerat, 2015) – will tend to identify innovation in remoter places and uncover a variety of adaptive processes that allow innovative firms to operate there.

The choice of approach is often a function of available data. Observing incremental innovation processes and firm adaptation requires several case studies or costly original surveys that are often considered too specific for publication, a dilemma highlighted by Ferru and Rallet (Chapter 5, this volume). Patent data are therefore the basis of many empirical studies that search for general spatial trends in innovation, despite this measure being very specific and spatially biased (if used as a general indicator of innovation’s geography). It is usually product innovations that are patented, more so in some sectors than in others; patents can be used as a strategic defensive mechanism, with no intention of producing a new product; smaller firms tend to patent less than larger ones and so on. National innovation surveys, an alternative better suited to exploring entrepreneurial innovation, usually lack detailed geographic representativity and often gather information on firms (not establishments), which limits their usefulness for studying the geography of innovation.

Confusion 4: Generalization from ‘Successful’ Regions

A fourth confusion – that relates to confusion 1 – is between the study of successful regions, that is, regions that have built their competitive advantage from particular kinds of localized learning, and which are functionally integrated within a territorially embedded, socio-cultural and socio-economic structure (Asheim et al., this volume), and unsuccessful regions, that is, regions that lack the infrastructure, human capital, cooperation partners, technological opportunity and access to markets that are assumed to be prerequisite for innovation (Isaksen and Karlsen, Chapter 16, this volume).

It is often deduced (rather than demonstrated) that firms in non-successful regions will have trouble producing innovations: indeed, it is assumed that if a region is unsuccessful...
The geographies of innovations: beyond one-size-fits-all

(in decline, low gross domestic product (GDP), without clusters and localized learning) then necessarily its firms cannot be very innovative. Only recently have studies begun to explore the way in which firms in apparently unconducive environments manage to innovate (for example, Grillitsch and Nilsson, 2015; Shearmur and Doloreux, 2016). Scholars implicitly rely on criteria relevant for densely populated and urbanized areas to explore and assess innovation: however, such criteria may not be appropriate for capturing innovation in places where critical mass, density of actors, proximity and concentration of economic activities are absent.

Confusion 5: Knowledge Diffusion, Knowledge Creation and Knowledge Value

One reason for examining the role of geography in innovation is the idea that some types of knowledge diffuse in limited ways across space. Whether knowledge is considered to be tacit or codified, sticky or slippery, symbolic or analytical (Tödtling and Trippl, Chapter 7; Aslesen and Isaksen, Chapter 8, this volume), different types of knowledge are associated with different communication modes, some requiring face-to-face interaction, others the exchange of written documents, others electronic communication. This basic idea has underpinned the study of localized knowledge spillovers since the early 1990s.

An alternative way of linking knowledge with space, but one not always clearly distinguished from the study of knowledge diffusion, is to analyse the process of knowledge creation. The question isn’t about how existing knowledge is transmitted across space but how agents coordinate, interact and combine knowledge to create new solutions and innovate. The focus is therefore on coordination and interactions more than on the diffusion of existing knowledge.

From a theoretical point of view, this distinction refers to the debate between resource allocation and resource creation in the economic field. Just as innovation studies do not always distinguish between system-wide innovation (leading to system-wide growth) and local innovation (which may or may not lead to local growth – see confusion 2), when knowledge is considered, its creation and allocation are, likewise, not always distinguished. Since innovation occurs at the intersection of knowledge diffusion and knowledge creation, and since research often adopts one or other (but usually not both) of these perspectives, the choice of perspective produces different interpretations of the geography of innovation.

An important aspect of the knowledge diffusion/creation question relates to the way in which different types of knowledge travel. Innovators relying on time-sensitive knowledge, or those relying on knowledge that is rooted in space (such as knowledge of a terroir), will clearly benefit from being in proximity to the knowledge source. Innovators relying on knowledge that keeps its value or that is ubiquitous (such knowledge will complement internal capacities) will be less tied to agglomeration or proximity to knowledge sources. Knowledge, which is often discussed generically, or categorized in terms of its content (knowledge bases) or its embodiedness (tacit versus codified) has rarely been thought of in terms of the way its value to innovators can alter across time and space (Shearmur, 2015).
Confusion 6: When (and Where) was Research Conducted and When (and Where) were Concepts Developed?

We have already discussed, in the previous section, the care that must be taken when considering the geographic, cultural and even individual contexts within which ideas about geography and innovation are developed. A final source of confusion to bear in mind is the timing of research and of the concepts it develops. In 1995, as alluded to above, the internet and mobile phones were still in their infancy, yet many of the ideas about clustering, agglomeration economies, geographic proximity, places and territory were well developed by then. In the early 2000s, the internet and mobile communications had become ubiquitous in cities, but many economic actors had not yet taken strategic decisions (in particular, location and networking) on their basis. By the late 2000s these technologies had become normalized and available in most places (Tranos, Chapter 21; Komninos, Chapter 10, this volume). These general-purpose technologies have now been adopted, and we can expect changes in the configuration of interactions and location choices to become increasingly evident (MacPherson, 2008). The direction of change is uncertain, but it would be surprising if these technologies did not alter the way in which information and knowledge flow, and with it the geographic configuration of innovation.

There are no doubt other areas where clarity is lacking, but these six confusions run through the literature. Authors implicitly adopt positions and conceptual frameworks: understanding why one author (or school of thought) does not seem to come to the same conclusions as another often involves understanding where each of them has positioned themselves along these fault lines. Each researcher (or school of thought) is quite clear what they mean by ‘innovation’ and ‘knowledge’, and has their own motivations for undertaking research on the geography of innovation. But at a wider scale, dialogue between researchers and schools of thought is often stymied because it is difficult to acknowledge the limitations of one’s own approach or to recognize that other, equally valid approaches, exist.

HANDBOOK STRUCTURE

The Handbook comprises seven parts made up of 27 chapters. The chapters in Part I set the scene by introducing different theoretical approaches, concepts and broad empirical data related to the geography of innovation. Some of these are renewed iterations of classic approaches (Asheim et al., Chapter 2), others question some key assumptions that have structured our understanding of the geography of innovation (McCann and Ortega-Argilés, Chapter 1; Rodriguez-Pose and Wilkie, Chapter 3), and others present (Spigel, Chapter 4) or call for (Ferru and Rallet, Chapter 5) new ways of approaching the geography of innovation.

Part II examines relatedness and the geography of knowledge activity in different sectorial and regional contexts. All three chapters in this part focus on knowledge bases and path dependency. Balland (Chapter 6) argues for the need to study this dynamically, Tödtling and Tripl (Chapter 7) focus on knowledge sourcing and Aslesen and Isaksen (Chapter 8) on the role that tacit knowledge plays in the clustering of certain activities.
Part III examines the complexity of innovation and creativity in the context of agglomerations and cities. The chapters here take very different approaches. Wolfe (Chapter 9) emphasizes the role that large cities play in attracting creative people who generate ideas that lead to innovation and carry out the innovative process itself. Komninos (Chapter 10) focuses on the way smart cities are enhancing knowledge exchanges and interactions between economic agents by introducing communication, transport and data sharing technologies – these, he argues, increase the capacity of cities to foster innovation. Comunian et al. (Chapter 11) study the way in which UK graduates in creative industries move towards larger cities – London in particular – which houses both educational institutions and job opportunities in these sectors.

In Part IV, the Handbook changes gear. The selection of chapters in the part titled ‘Beyond Agglomeration and Clusters’ presents a series of alternative views – backed by evidence – of the geography of innovation. Grossetti et al. (Chapter 12), looking at scientific knowledge production, deconstruct the idea that large universities – and those in large cities – are more scientifically productive than smaller ones. Gibson and Brennan-Horley (Chapter 13) take issue with cluster theory, presenting evidence that clusters are not necessarily what they seem. Huber and Fitjar (Chapter 14) question whether there is evidence of localized knowledge exchange within clusters, Bain (Chapter 15) points out that innovation and creativity also take place in low density ordinary suburbs and Isaksen and Karlsen (Chapter 16) make the case that innovation can – and does – occur in peripheral regions.

The chapters in Part V discuss innovation policy. Bradford and Bramwell (Chapter 17) examine regional innovation policy in a context of globalization and multi-scalar governance. In Chapter 18, Uyarra and Flanagan suggest that regional innovation policy should itself be understood from an evolutionary perspective as agents appropriate and modify standard policy prescriptions. The two following chapters examine specific policy contexts – clusters in Shenzhen (Yang, Chapter 19) and high-tech regions in southern Britain (Lawton Smith, Chapter 20): beyond the specificities of each policy approach, the differences in underlying assumptions about how the economy works are striking.

In Part VI attention turns to global networks, starting with the internet and social networking platforms that facilitate interactions and coordination both locally and across the globe (Tranos, Chapter 21). Given this key infrastructure, which was inaccessible to most economic agents only 20 years ago, Chaminade et al. (Chapter 22) describe the structure of global innovation networks, Breschi et al. (Chapter 23) the flows of highly skilled migrants – whether they are migrating independently or within multi-national corporations – and Mattes (Chapter 24) the ambiguous geography and partial embeddedness of innovation processes within these same corporations.

The last part, Part VII, examines an aspect of the geography of innovation that has rarely been studied. Rather than examine the way in which innovation plays out across, or draws from, different regions, the authors of these chapters explore the consequences that innovation can have on people and communities located in particular regions. Lee (Chapter 25) argues that innovation, whilst necessary, often accentuates inequality in the places where it is most concentrated. Innovation also leads to inequality between places: paradoxically, as Shearmur (Chapter 26) argues, many regions and small towns house innovative companies, yet do not gain any benefit from this despite bearing the costs. Finally, Klein and Tremblay (Chapter 27), more optimistically than Lee and Shearmur,
suggest ways in which creativity and innovation can be harnessed for the benefit of local communities.

These chapters illustrate the many ways in which geography and innovation are interrelated, and the way in which significant analytical and empirical developments over the last three decades have pushed our understanding forward. However, as we move forward, the relationship between geography and innovation is changing. First, it is increasingly understood that innovation is complex and therefore innovative firms and organizations exhibit a wide variety of strategies, each differently attuned to different geographic contexts (Grillitsch and Nilsson, 2015). Second, the heterogeneity of places (or of geographies) implies that observed differences may well increase rather than decrease: without a detailed understanding of the geographical context we are dealing with, it is very difficult to generalize (Ndabeni et al., 2016). Third, the way in which social processes and knowledge creation relate to space and place is being reconceptualized (Shearmur, 2011; Rutten, 2016; Spigel, Chapter 4, this volume). Therefore, as we move forward, more questions are uncovered, many of which require new insights to capture the relationship between innovation and geography. In particular, the idea that cities, clusters and physical proximity are essential for innovation is evolving under the weight of new theorizing and empirical evidence.

This Handbook makes progress towards these goals by challenging the many ideas and concepts that emerged during the course of the 1980s and 1990s, and by fully taking into account the new reality of the internet, mobile communication technologies, personal mobility and globalization. This does not entail turning our back on well-established and supported ideas, but allowing a series of new ideas and authors to enter the arena and join the debate.

NOTES

1. Bathelt et al. (2004) introduce the buzz-and-pipelines metaphor when describing connections between local and non-local knowledge flows that underpin innovation in different clusters. They argue that innovation rests on both linkages at the local level and knowledge interactions with distance sources and partners. Empirically, these ideas have been tested by, among others, Belussi et al. (2010) who show that information and knowledge exchange transcend regional boundaries, and that cooperation with geographically distant partners increases productive inputs and processes, and which favour economies of variety.

2. The point made here – which relates particularly to innovation studies – is one that is increasingly well rehearsed in the wider geographic literature. See, for instance, Parnell and Robinson (2012) and Edensor and Jayne (2012) who question the extent to which urban theory developed in one context can be transferred to another. Lundvall et al. (2009) suggest – with substantial qualification – that the innovation systems approach (writ large) can be useful in the context of developing economies.

3. Objectivity can of course never be achieved. However, it is used here in the sense that it is an ideal worth striving for, which involves robust methodology, reflexivity and recognition that one can never be totally aware of one’s own biases.

4. To clarify matters, and subject to each author appropriating the concept of innovation in their own way, this book focuses on economic innovation, that is, innovation processes that ultimately lead to new-industry formation or to existing firms introducing new products, processes and services. These innovation processes can occur within a system, within a firm, and can be encouraged (or inhibited) by policies and institutions (Uyarra and Flanagan, Chapter 18, this volume) and technologies (Komninos, Chapter 10, this volume). Ultimately, though, it is innovation in the economic sphere that is the subject of this book.
REFERENCES


The scope of the literature on the geography of innovation is vast, the variety of approaches great, and agreement (and disagreement) on central issues and concepts sometimes difficult to pinpoint: it is therefore not possible to review it all adequately. The collection of chapters in Part I covers various specific facets of the geography of innovation literature, and sheds light on different aspects of the debate surrounding its theories, concepts and empirics. In particular it covers the role played by geographic factors in enabling or generating innovation, thereby, it is hoped, securing the dynamic growth and development of regional economies.

The first contribution by McCann and Ortega-Argilés provides a conceptual overview of regional innovation, R&D and knowledge spillovers. This chapter seeks to place the discourse on the relationships between innovation and geography within the wider (non-spatial) literature on the economics of knowledge, technology and innovation. According to the authors, this ‘is neither redundant, nor superfluous’ as this literature ‘is essential in order to develop a reasonable and realistic way of understanding these relationships’ (Chapter 1). Whilst not denying that agglomeration and geographical clustering theories can help make sense of some aspects of the innovation process, they emphasize that the relationships between geography and innovation are truly complex and will vary according to the nature and role of knowledge being created and exchanged. They therefore stress the need to develop analytical arguments relating to the conditions and mechanisms under which innovation, knowledge spillovers and clusters develop and co-exist, rather than assuming that there is a direct relationship between innovation and geographic co-location.

Chapter 2 by Asheim, Grillitsch and Trippl reviews and discusses the conceptual cornerstones of the Regional Innovation Systems (RIS) idea. RIS research is a recurring theme in the geography of innovation literature, as many scholars have endeavoured to identify, characterize and categorize the factors explaining how a region transforms and develops into an innovative one, with the objective of better understanding the uneven geography of innovation. They show that the literature on RIS has grown impressively over the last two decades, and has extended to incorporate concepts such as knowledge-bases and the interplay between internal interactions and external connections to actors and institutions. The growth of work in this area is driven by the policy implications of these analyses in the light of, on the one hand, innovation being recognized as a determining factor of local economic growth and, on the other hand, the regional level being considered the most adequate scale at which to stimulate and support innovation.

Rodríguez-Pose and Wilkie’s chapter provides a conceptual and empirical overview of the spatial concentration of innovation in cities and the potential biases associated
with the assumption that innovation mainly occurs in cities. They explain the reasons why innovative firms in cities are expected to perform better than innovative firms in peripheral regions. One explanation, around which the core argument of the chapter is developed, rests on the benefits of geographical proximity and spatial concentration that are mainly associated with large agglomerations where innovative firms benefit from the co-location of similar or related firms, access to markets, labour, suppliers, networks, specialized services and technological infrastructure. In other words, they show that most theoretical predictions that explain higher innovation performance in large cities rely on the proposition that co-location and concentration of economic actors are conducive to innovation. Ultimately, this ‘results in a geography of innovation characterized by a distinct “urban” or “city” bias’ (Chapter 3). Given the empirical material presented in their chapter, which shows that the concentration and growth of innovation in cities is observed in some countries but not in others, Rodríguez-Pose and Wilkie suggest that theories developed to understand innovation in cities may not be suited to explain innovation in peripheral regions. Like McCann and Ortega-Argilés and Ferru and Rallet (Chapter 5), they show that the relationship between geography and innovation is complex, and warn us against relying on theories that explain innovation in cities to explain innovation that occurs elsewhere.

In Chapter 4 Spigel provides a critique of how the notion of culture is used in the RIS and other regional innovation literatures. His point of departure is the work of Bourdieu, in particular, his conceptualization of practices as emerging from the intersections of different fields, habitus and internalised dispositions: Spigel draws upon these ideas to provide a framework for understanding the uneven geography of innovation. From his perspective, culture cannot be considered as being homogeneous within regions: ‘RIS will have a diverse array of cultural influences affecting different actors and firms’ (Chapter 4). Actors within a region will be operating within different fields, drawing upon different social networks and playing by different rules of the game (or, even, playing different games). The observed geography of innovation will be the outcome of these interconnected processes. As a result, Spigel’s chapter can be seen as a partial response to previous chapters, furnishing some building blocks to better conceptualize and understand the complexity of the relationship between geography and innovation.

The final contribution in this section is Ferru and Rallet’s investigation of the link between proximity and innovation. Ferru and Rallet in Chapter 5 bring together critical perspectives on the question of the geography of economic activities, and of innovation in particular. The interest here is to provide, through the lens of the French School of Proximity, a critical review of the development of these numerous studies by looking at how proximity research has developed, and by proposing some avenues for moving the research forward. In line with the arguments stressed by McCann and Ortega-Argilés (Chapter 1) and Rodríguez-Pose and Wilkie (Chapter 3), Ferru and Rallet emphasize that the geography of innovation is far from being fully understood. They also, by taking a historical view of proximity studies, show how ideas develop at particular times and in particular places, and how ideas can sometimes run their course. They suggest that the field of proximity studies in particular – and that of the geography of innovation more generally – may be in need of fundamental overhaul.

Taken together, these five chapters do not resolve the theoretical debates, nor do they provide a completely coherent body of thought. Rather, they emphasize that the
study of the geography of innovation is in a state of flux, as new empirical results, new general purpose technologies, new ways of thinking and detailed reconsideration of existing theory necessarily lead to new questions being asked and old certainties being re-evaluated. It is the dialogue between these more conceptual chapters, rather than each taken individually or in sequence, that frames this *Handbook*. 
1. Regional innovation, R&D and knowledge spillovers: the role played by geographical and non-geographical factors

Philip McCann and Raquel Ortega-Argilés

1.1 INTRODUCTION

Debates regarding the role played by innovation in driving changes in economic geography, and, conversely, the role played by geography in shaping innovation processes, are multidimensional and varied in nature. Any comprehensive analysis of these inter-relationships is likely to include discussions of issues such as the formation of clusters and agglomerations, the role of different types of firms ranging from small and medium-sized enterprises (SMEs) through to multinationals, and the role played by different types of knowledge-related institutions, including private research and development (R&D) centres, universities and research institutes. One of the issues for which there is overwhelming evidence is that R&D is related to productivity (Ortega-Argilés and Brandsma, 2010; Ortega-Argilés et al., 2010, 2011, 2015a, 2015b; Ortega-Argilés, 2012a, 2012b) via a mechanism in which R&D fosters innovation, which itself then drives productivity. However, exactly how these mechanisms relate to geography is far from straightforward.

In economic geography and urban economics there is often a tendency to assume certain types of relationships and mechanisms, and then to develop analytical arguments on the basis of these assumptions, rather than testing the assumptions themselves. For instance, innovation is often assumed to be a key driver of city growth via the positive impact that external knowledge spillovers have on a firm’s competitive behaviour, while the existence of such local external knowledge spillovers is often simply assumed. Indeed, the idea that observations of agglomeration-type behaviour are themselves reflective of the existence of local knowledge spillovers is a widespread notion underlying many different models and empirical exercises, even though in many cases there is little or no independent evidence to support such a claim. The result is that the role played by cities in fostering innovation, and the role of innovation in shaping spatial behaviour and in driving city growth, tends to be treated as synonymous with knowledge spillovers. In other words, the existence of innovation processes is treated as being largely equivalent to the existence of local knowledge spillovers, which themselves are assumed to exist locally due to observed processes of local urban growth. Yet, if indeed innovation, knowledge spillovers and clustering are largely synonymous with each other, as urban economists in particular are fond of suggesting, then much of the vast literature on the economics of knowledge technology and innovation appears redundant. We argue that this is not the case, but appears so because of the circularity of the urban economic logic: by avoiding many of the complex issues raised by the non-spatial literature, this logic is ultimately of little help in furthering our understanding of local development processes.
When the relationship between innovation and geography are being discussed, rather than assuming generic patterns it should be the conditions under which innovation, knowledge spillovers and clustering do (or do not) co-exist and are (or are not) consistent with each other that are the point of departure. From this perspective, the vast non-spatial literature on the economics of knowledge, technology and innovation is neither redundant nor superfluous. On the contrary, this literature is essential in order to develop a reasonable and realistic way of understanding these relationships. In particular, while the wider debates as to exactly how innovation shapes geography via market transactions (McCann 2007) or the institutional settings (Shearmur, 2011; Barca et al., 2012) often remains somewhat clouded due to often rather heroic assumptions that underpin the different geographical approaches, a detailed examination of how the non-spatial literature informs the spatial literature is invaluable.

The aim of this chapter is therefore to unpick many of the widely held assumptions within economic geography and urban economics concerning the relationship between knowledge spillovers, technology, R&D and innovation, and to consider how the non-spatial literature can provide sound underpinnings for the more explicitly spatial research. Parts of the chapter draw significantly on Ortega-Argilés (2012a) and though the literature surveyed here is wide-ranging it remains only a small subset of non-spatial and spatial literatures examining innovation and economic geography. The material referred to here, however, does provide a reasonably comprehensive picture of many facets of current evidence and debates, and as such is intended to provide a roadmap through the vast field of analysis. The chapter is organized as follows. The next section reviews the literature on the nature, role and links between R&D, innovation and productivity. Section 1.3 examines innovation from the perspective of the resource-based view of the firm, and Section 1.4 discusses the characteristics of knowledge and technological regimes as shaping the evolution of the firm’s innovative behaviour. Section 1.5 sets the insights of these various non-spatial and firm-centred arguments in the context of geography, and discusses spatial behaviour on the basis of prevailing technological regimes. The final section provides some brief conclusions.

1.2 R&D, INNOVATION AND THE DETERMINANTS OF FIRM-LEVEL PRODUCTIVITY

Schumpeter’s (1934) basic competition argument is that all entrepreneurial innovations – that is, new or significantly improved combinations of products, processes, raw materials, markets, organizational solutions – will count economically as long as they are not immediately copied. In other words, innovation generates temporary monopoly rents for firms, because market competition is not primarily about prices but about the opportunity to perform better tomorrow than the market leaders do today. This Schumpeterian approach, which is also explicitly formulated in modern evolutionary economic theory (Nelson, 1995), is also consistent with different approaches that allow for heterogeneity and variety among actors regarding information, knowledge, capabilities, as well as among products and processes.

Innovation has traditionally been seen as the outcome of collision between technological opportunities and user needs, an outcome usually embedded in new products: as
such, innovation is a critical dimension of economic value creation (Schumpeter, 1934). During recent decades researchers have broadened the concept of innovation to include non-technological innovation, which can include: design innovation (Walsh, 1996; Verganti, 2006), business model innovation (Amit and Zott, 2001; Zott and Amit, 2010) and process innovation (Hammer, 2004). Furthermore, interest in different innovation contexts – service environments as opposed to the well-studied product environments – is increasing (Drejer, 2004).

One strand of the conceptual literature on the link between R&D and firm productivity analyses innovation output as an intermediate step that catalyses the effect of R&D on firm performance, mainly measured by labour productivity or profitability. Schumpeter’s (1934, 1942) seminal work describes a largely linear relationship, with R&D investment influencing technological performance, which in turn influences profitability. Innovation is seen as the outcome of the collision between technological opportunities and user needs (Schumpeter, 1934). Alternatively, Nelson and Winter (1982) view the innovation-productivity mechanism as a circular one whereby innovation success influences profits, which influence R&D investment, which influences innovation probability and thereby success (success breeds success).

Capturing these mechanisms empirically, however, is difficult. Building on Griliches’s (1958) and Mansfield’s (1965) pioneering work, attempts to analyse and quantify the productivity effects of innovative activities have proved to be challenging and controversial. In recent decades this research has been augmented by the new theoretical underpinnings of endogenous growth theory (Romer, 1990; Aghion and Howitt, 1998), which suggests that economic outputs are positively correlated with the flow of new products, whether radical or incremental. Indeed, in emphasizing innovation, it is important to remember that innovation based on imitation or technology transfer can also result in substantial productivity growth of economies (and firms) behind the technological frontier. Technology transfer is not necessarily automatic and is contingent on the levels of knowledge and expertise in the firm, industry or country to which the technology is being transferred. This line of thought is closely linked with the idea that some knowledge is tacit or hard to acquire without direct experience. By actively engaging in R&D in a particular intellectual or technological field, one acquires tacit knowledge that can therefore help in more easily understanding and assimilating the discoveries of others. Even then, the transfer of technology may be far from automatic. While the firm, or more broadly the business enterprise, plays a large role in determining the characteristics of technological change, the firm’s ecosystem, including supporting institutions and legal structures, also remains of great importance.

More recent theoretical contributions have therefore focused on opportunities to improve innovation success by opening up the R&D funnel and engaging with ecosystems and firm surroundings. Examples include customer involvement in the early stages of R&D (Von Hippel, 1990), sourcing of innovation ideas and projects externally through licensing, partnerships or intermediaries (Chesbrough, 2006; Chesbrough et al., 2006), as well as the potential use of alternative business models or routes to commercialize promising technology (Chesbrough et al., 2006). Brécard et al. (2006) find that R&D produces its full effects on two forms of innovation, namely, aggregate factor productivity gains and improvements in product quality. However, as Teece (2010) explains, technology-driven firms face the problem of how to manage and integrate the
output of highly skilled experts (literati and numerati) across countries, time zones and organizational boundaries.

All innovations or innovation activities share the common characteristics of being novel or new, of reflecting improvements on existing blueprints and of being undertaken in order to overcome future uncertainty (Gordon and McCann, 2005). In general, innovation can be distinguished along the following dimensions:

- **Type**: technological – product and process innovation (Hammer, 2004) – or non-technological – organizational innovation (structural, procedural), marketing and design innovation (Walsh, 1996; Verganti, 2006), business model innovation (Amit and Zott, 2001; Zott and Amit, 2010) and managerial innovation, among several others.
- **Mode**: novel innovator (strategic and intermittent), technology modifier and technology adopter.
- **Socio-economic impact**: incremental, disruptive or radical.

Within this broad framework, the role of R&D in stimulating innovation has long been viewed as central to economic performance and social welfare. The existing economic literature has indeed found robust evidence for a positive and significant impact of R&D and innovation on productivity at the firm level. This consensus about the existence of a positive and significant impact of R&D on productivity is based on a variety of studies using different proxies for productivity according to the data available. The estimated overall elasticity of productivity with respect to R&D is positive, statistically significant and with a magnitude – depending on the data and the adopted econometric methodology – ranging from 0.05 to 0.25 (Mairesse and Sassenou, 1991; Griliches 1995, 2000; Mairesse and Mohnen, 2001). However, these elasticity estimates tend to be higher from cross-sectional estimators and lower from within or difference estimators. This is consistent with the idea that, given the presence of measurement error, coefficients are biased downwards when ‘within’ and first difference estimations are performed.

The majority of studies on the relationship between innovation and firms’ economic performance use the production function approach, where different measures of firm performance (mainly productivity) are explained by several independent variables such as physical capital, human capital, R&D and other innovation-related investments as well as by firm size and maturity. However, Griliches and Mairesse (1984) point out that estimation results for the majority of models applying production functions, including their own analyses, are likely to be biased due to simultaneity and measurement error. This is because investment in physical capital, R&D expenditures and employment might well be influenced by productivity. To keep simultaneity problems to a minimum, and to take into account the lag between R&D investment and productivity gains, several authors have included R&D stocks in estimated equations using the inventory method, or have estimated a simultaneous equation model, following the landmark Crépon et al. (1998) methodology.

This seminal paper on the analysis of links between R&D, innovation and productivity examines these relationships in the context of French manufacturing. In their work, which builds on Griliches (1986) and Griliches and Mairesse (1984), they examine issues of selection bias, simultaneity bias, specification and estimation. They confirm the
presence of a positive relationship between research and innovation and between innovation and productivity. This paper has spawned a whole series of similar papers, and from these we see that the estimated relationships are sensitive to the type of model, estimation method, measures of firm performance, sub-sample of business sectors, type of innovation, data source and specification of the innovation models used. As Hall and Mairesse (2006) explain, in terms of understanding the channels linking investment in knowledge and productivity growth, Crépon et al. (1998) combine the important but largely separate lines of empirical research that had evolved since Griliches’s original work.

Crépon et al.’s (1998) improvement and amplification of Griliches’s original work has been possible because of better micro-data sources: the construction of surveys for various purposes has facilitated the incorporation of new determinants in the models and the application of more sophisticated techniques. Several microeconometric studies have gathered evidence regarding other channels of the knowledge-productivity link. These studies attempt to replicate the Crépon et al. model with higher levels of sophistication in the measurement of inputs, in the data used, in the methodology applied and in the set of country comparisons. The key results of these studies can be summarized as follows. The probability of doing R&D increases significantly with firm size, captured by the number of employees, and also with their market share and diversification activities (Crépon et al., 1998). However, while evidence from firm-level studies for a range of countries confirms a positive role for R&D expenditure in explaining productivity growth, R&D expenditure has only limited explanatory power regarding differences in productivity rates between firms, sectors and countries (Griliches and Mairesse, 1990). As reported by Nadiri and Prucha (1996) and Mairesse and Mohnen (2001), most studies on R&D expenditure find a positive net effect on both value-added and turnover, although the advantages of R&D decline when its effect is evaluated over time (Klette and Kortum, 2004). Labour productivity increases significantly with the intensity of innovation sales for manufacturing and service sectors (Lööf and Heshmati, 2006). The estimated elasticity of productivity levels with respect to innovation output increases by about 50 per cent when physical capital is not controlled for. The lack of a control for skill increases the elasticity by about 25 per cent (Lööf and Heshmati, 2006). The elasticity of value-added per employee, in levels and growth, differs little between manufacturing and services.

Although these estimated impacts of innovation on productivity are subject to a variety of econometric and other reservations, there is striking similarity between samples of firms, which is not well documented in the literature. Unlike productivity, employment increases with innovation outputs only in service firms (Lööf and Heshmati, 2006). These researchers also find that sales growth increases with the level of innovation output, but only for manufacturing. Innovation productivity is higher for firms sharing knowledge through R&D partnership(s) thanks to internalized spillovers. Innovation productivity is also higher for firms belonging to a group, where R&D costs and knowledge are more likely to be spread across affiliates acting as a natural consortium. Kremp and Mairesse (2004) observe a relationship between innovative performance and four different knowledge management practices within firms, the promotion of a ‘knowledge sharing culture’, the adoption of incentive policies to retain R&D professionals, the employment of alliances for knowledge acquisition and the adoption of a written knowledge management policy by the firm. Halpern and Muraközy (2009) find that innovative firms are both more productive and more likely to trade and export into more countries.
Foreign firms are more likely to innovate compared to similar domestic firms, but R&D is a weaker predictor of their innovative output. Instead, they find that the exceptional export performance of innovative firms is primarily driven by a diversified export strategy, exporting to more markets rather than exporting more products or at larger intensive margin.

Another important finding is that different types of innovation – product and process innovation in the cases described below – have different determinants. Firm size enhances process innovations more than product innovations. Robin and Mairesse (2008) re-examine the Griffith et al. (2006) results, using more recent data for France, and find a more pronounced effect of innovation on productivity, especially in the case of firms conducting both product and process innovations. Cabagnols and Le Bas (2002) find that economic competition favours process innovations, whereas technological competition (the percentage of innovators in the same sector) stimulates product innovations. They also find that process innovators tend to rely on upstream sources of knowledge and on consortium research, whereas product innovators source their knowledge from downward and horizontal links.

Van Pottelsberghe de la Potterie (1998) concludes that although there have been a considerable number of studies on R&D – productivity linkages – these studies are virtually impossible to compare because they differ with respect to key dimensions such as aggregation level (firm, industry, country, macro-regions such as European Union (EU) versus United States), econometric specification, data source, measurement of R&D, measurement of productivity and period of investigation. Thus, the complexity of innovation processes and the variety of possible components and elements of these processes remain difficult to disentangle econometrically. Our empirical models remain heavily guided by conceptual frameworks, and the result is that, in many ways, the economic theory of the firm is still, as Rosenberg (1982) pointed out, largely a ‘black box’ when it comes to understanding the processes that result in the creation of new products and services and their profitable commercialization. Given this uncertainty, ideas about the geography of innovation – which assume an understanding of innovation processes that does not reflect the current state of the literature – may need rethinking. We shall return to this in later sections, and now consider the resource-based model of the firm.

### 1.3 The Resource-Based Model of the Firm, Strategic Management and the Implications for Firm Innovation Behaviour

One way of making progress on these issues is to approach them in terms of the role played by knowledge. The literature on the economics of knowledge (Foray and Freeman, 1993; Foray, 2004, 2009; Swann, 2009) provides various different ways of thinking about innovation, and about the relationships between innovation and economic geography (Iammarino and McCann, 2013). The strategic management literature argues that in innovation-driven economies, intangible assets, including knowledge spillovers and relationship capital, are critical to the creation and production of new goods and services. In such economies, it is argued that how the firm exploits these assets is a key mechanism of technological change (Teece, 2010). Knowledge assets are tacit to varying degrees
and costly to transfer. The market for know-how is also riddled with imperfections, which favours internalization to capture strategic value, in that certain assets are more valuable to one firm than another. Assets that have such special value are referred as strategic assets, and these can take the form of ‘dynamic capabilities’, ‘resources’ and ‘competences’.

Following the seminal contributions of Penrose (1959), the strategic management literature (Teece, 1984) and the systems-of-innovation literature (Lundvall, 1992) frame the analysis of innovation by focusing on the role played by the firm’s resources, competences and capabilities.

- **Resources** are regarded in the resource-based view (Penrose, 1959; Teece, 1984) as being those firm-specific assets that are difficult for other firms to copy or imitate, and the difficulty of imitation means that often they tend to be intangible rather than tangible, although both are possible. In particular, these types of assets tend to display property rights features whose boundaries are somewhat difficult to define and, as such, are both rather fuzzy and idiosyncratic in nature (Teece, 1984), and these characteristics themselves significantly inhibit such resources being traded or transferred to competitor firms (Teece, 1984). Teece (1984) lists various examples of resources that display these features, such as intellectual property, the embodied knowledge and specific skills within groups of specialized workers, customer relationships and process know-how (Teece, 1984). Over many decades the resource-based framework has developed within the management literature, building heavily on the work of Penrose (1959) and Teece (1984) amongst others, and this literature is based on the principle that the firm earns rents from leveraging its unique resources, which are difficult to monetize directly via transactions in intermediate markets. This in turn gave rise to the analysis of learning and knowledge management as the means to develop and augment new, hard-to-imitate resources. However, while resources are a stock not a flow, they can be constantly renewed. The need for renewal is amplified in fast-moving environments such as those characteristic of high-tech sectors (for example, computers), but the need to renew resources can also occur in ‘low-tech’ industries (for example, life insurance).

- **Competences** are a particular kind of organizational resource, resulting from activities that are performed repetitively, or quasi-repetitively. Organizational competences require collective effort, and represent distinct bundles of organizational routines and problem-solving skills.

- **Dynamic capabilities** are defined by Teece (1984) as the firm’s ability to build, integrate and reconfigure both external and internal resources and competences in order to respond to and influence the evolving business environments (Teece, 1989, 1996, 2007). According to the resource-based view (Teece, 1984), dynamic capabilities may be embedded in various firm-specific systems and routines for adapting to change, and these may involve, for example, different product development processes, different investment strategies, different managerial approaches or different entrepreneurial initiatives (Teece, 1984). Taken together, these different systems, routines and responses reflect the efficiency and efficacy with which the firm is able to reconfigure its resources to best fit the evolving business environment (Teece, 1984). In other words, dynamic capabilities also reflect the capacity of a firm to
orchestrate and reorganize its activities, resources and assets within the broader system of global specialization and diversification.

The elements in this literature that are regarded as central include organizational schemes, teams, hierarchies, incentive systems and outsourcing. However, the key idea is that resources, competences and dynamic capabilities may be built. Dynamic capabilities are based on the skills, procedures, organizational structures and decision rules that firms utilize to create and capture value. For instance, different innovation activities such as exploration (e.g. research on a potentially disruptive technology) and exploitation (e.g. selling mature products) will require different managerial styles. Whether the enterprise is currently making the right products and addressing the right market segments, or whether its future plans are appropriately matched to consumer needs or to technological and competitive opportunities, is determined by its dynamic capabilities. Managers must be able to sense the opportunities, craft a business model to capitalize on them and reconfigure their organizations, and sometimes their industries, as the business environment and technology shift. Management involves not only motivating talent and ensuring the job gets done, there is also a strategic component – what tasks to assign, what priorities to set, what resources to use and where to get them from. To respond to these challenges, business enterprises need to develop capabilities and deploy them on a global basis (Teece, 2010). Sensing (identification and assessment of an opportunity), seizing (mobilization of resources to address and opportunity and capture value from doing so) and transforming (continuing renewal) are the particular attributes of firms that enable them to evolve and co-evolve with the business environment. Such capabilities are critical to long-term productivity and profitability.

As Teece (2010) points out, R&D is not the only source of productivity gains. The literature has shown that different determinants have a direct influence on firm’s performance. In this sense, a firm’s inputs can be classified into traditional inputs and new discoveries. Traditional inputs comprise a firm’s inputs such as human capital, physical capital, information and communications technology (ICT) and information technology (IT) services and capital, financial capital, materials and energy, while new discoveries comprise new sources of firm growth such as knowledge and innovation management, along with dynamic capabilities. The strategic management and resource-based literatures therefore see major differences between two different generic types of firm model – broadly defined as the ‘industrial model’ and the ‘knowledge model’, with the latter reflecting a more modern and innovative model of firm organization (Ortega-Argilés et al., 2005) and management. The term ‘knowledge management’ is nowadays itself widely used in the literature to refer to the implicit or explicit practices employed by a firm to acquire new knowledge, and to rearrange and diffuse existing knowledge within the firm. It also includes strategies that are intended either to prevent the firm’s own knowledge from leaking out or to encourage the diffusion of its knowledge to partner firms and others from whom the firm might benefit via reciprocal knowledge exchanges. Although knowledge management is not identical to innovation, the two are often viewed as closely connected, in the sense that innovation can be viewed as the production of new knowledge, implying that firms which innovate will also be those more concerned with the management of knowledge thus produced. Knowledge management is important for firm productivity and performance because it is directly linked with the firm’s products.
and production processes. In addition, knowledge management plays an important role in setting the short-term and long-term capital strategies of the firm. Knowledge management is also directly linked with managerial strategies related to process outsourcing, diversification and internationalization. This is because knowledge management is linked to the formulation of better combinations of assets and resources, to strategically obtain the highest possible returns.

The strategic management and knowledge management literatures therefore contend that R&D and innovation-related investments can have higher returns when they are complemented with other factors, and this can be understood in two ways. In one way, complementarities will be seen in the firm’s core when activities not necessarily considered as R&D investments, such as business services, complement R&D activities and provide higher returns. In parallel, a series of complementarities found in the external environment can also act as a support for the firm’s internal R&D effort. These insights imply that to transform invention successfully into innovation requires a range of complementary activities, including internal organizational changes, firm-level training, testing, marketing and design alongside external linkages. Innovation rarely occurs in isolation and is often a highly interactive and multidisciplinary process, which increasingly involves collaboration by diverse networks of stakeholders, institutions and users. In recent years, economists have paid more attention to the idea that new technology requires substantial complementary investments, and there is increasing evidence of their effects. Complementary investments can be of an organizational nature. Technology alliances among competing firms can generate both private and societal benefits (Jorde and Teece, 1990; Teece, 1992; Baumol, 2002). More recently, Bresnahan and Greenstein (1999) describe such complementary investments as co-invention, and Bresnahan (1999) emphasized that firms must adjust their organizational structure and their work processes, which is a long and slow procedure, to take full advantage of new technologies.

In recent years, companies have implemented thousands of large and small ICT-based innovations in software applications, work processes, business organization, supply-chain management and customer relationship management. In the United States and elsewhere, computer investments have contributed to output growth (Brynjolfsson and Hitt, 1995, 1996, 2003; Lichtenberg, 1995; Jorgenson and Stiroh, 2000; Oliner and Sichel, 2000). The contribution of ICT capital (capital deepening) to labour productivity growth has been increasing over time and this effect is widespread across industries. Probably the most important technological input to services are ICT products.

The impact of IT at the industry level is primarily understood by distinguishing between the IT-producing sectors and the IT-using sectors because during the 1990s productivity gains were primarily associated with the former whereas in the following decade productivity gains were much more centred on the latter. Their impact on productivity is greater in ICT-producing and ICT-using industries than in more traditional sectors, but nevertheless there are also significant effects in traditional sectors. In most manufacturing industries ICT has contributed to rationalizing production processes and raising productivity by reducing inputs, in particular, unskilled labour. In many service industries, ICT has had an additional impact on ‘product’ innovation, in turn implying increased use of high-technology inputs. Indeed, some service industries, and in particular finance and parts of the business service sector, are among the most intensive users of ICT. As such, most current studies emphasize the importance of complementary changes in a
variety of other organizational aspects when IT systems and processes are implemented (Brynjolfsson and Hitt, 2000; Bresnahan et al., 2002; Van Leeuwen et al., 2009).

In high-technology industries where the pace of technical change is high and where much of the newly emerging knowledge is tacit and uncodified, the generation of new products and services may have to overcome significant knowledge-related hurdles in order to distinguish themselves from the offerings of competing firms. In such an environment, the knowledge economics literature argues that it is valuable to have a highly skilled, and technically adept workforce, particularly where the firm develops an identity based on the relations it builds with other firms, either directly as suppliers or customers, or indirectly as collaborators and competitors.

The introduction of IT in companies implies more than simple automation and the substitution of workers by computers. IT implementation is associated with complementarities among three distinct kinds of technical change relating to: cheaper more powerful IT capital; organizational change; and new products, services or quality. Implementing these three forms of technical change concurrently transforms companies and leads to substantial changes in labour demand. Since all three involve substantial amounts of invention, the complementarity arises in the long run (David, 1990; Brynjolfsson and Hitt, 2000). Computers are best described as a general-purpose technology whose primary contribution is to make new production methods possible when combined with complementary investments such as new work systems, organizational redesign and business process re-engineering (Milgrom and Roberts, 1990; Malone and Rockart, 1991; Bresnahan et al., 2002).

IT-intensive production processes are based on an organization's strategic goals, such as new products and services, new quality levels, new capabilities or new efficiencies. In many cases they imply a need for complementary activities related to human capital improvements (education mix, skill mix); organizational changes, such as new hierarchies or work operations; new cognitive content of managerial work (Davenport and Short, 1990; Bresnahan et al., 2002); new supply chain management systems (Short and Venkatraman, 1992); and a higher service level for customers. IT computerization processes have therefore implied changes in workers’ capabilities, changes in managerial tasks, increases in demand for high skilled human capital and in many cases the substitutability of low skill human work. IT computerization process has primarily affected the tasks of lower level white collar and blue collar workers, because of their repetitive and routinized nature, while managerial and organizational tasks that required judgement, training, autonomy or creativity have been more indirectly affected. On the one hand, the implementation of a new technology requires a high level of cognitive skills that are important in adapting to change and exploiting data. As a result, there is increased demand for workers with skills to process and synthesize accumulated data associated with the implementation of new IT-intensive processes. On the other hand, there are more opportunities for managers and professionals to assess this increased information when designing organizations and new products. These new managerial activities thus require new managerial abilities – both quantitative skills and business knowledge. Therefore, complementarity between machinery and human capabilities leads to a wide variety of organizational structures that adapt better to the new requirements of communication and coordination. Additionally, because of the new skills requirements, there is the potential for implementing training or screening policies to analyse the improvements of existing workers and increase their
cognitive skills. Productivity should be higher in firms that successfully find complementary matches between IT, organizational structures and human capital investments than in those firms that cannot make such complementary matches. Yet, the importance of complementary assets makes it more difficult to determine the appropriate rate of return to R&D than many traditional econometric approaches suggest. If downstream complementary investments are substantial, it becomes very difficult to determine how much of the observed downstream returns are attributable to indirect R&D and how much is due to the many different forms of complementary investment.

These observations also underlie the importance of complementarities that are external to the firm, and an important literature (Teece, 2010) addresses factors in the firm’s external environment that impact firm-level innovative performance. The common argument of this literature is that firm-level innovation depends on the supply of skilled workers (who are not entirely mobile internationally), universities (for access to both highly educated faculty and research), financial institutions (especially venture capital), the legal system (especially intellectual property law and employment law), the supply base (including complementors), the domestic market and the presence of other firms in the same or related industries. In industries characterized by tacit knowledge that is not easily transferred over large distances, human capital practices are of particular importance to performance strategy because worker knowledge cannot easily be interchanged. Following this logic Cohen and Levinthal (1990, 1996) developed the concept of the ‘absorptive capacity’ of firms to adapt and acquire external and internal knowledge. Its premise is that the firm needs prior related knowledge to assimilate and use new knowledge. The embodied knowledge contained in a firm’s workers also represents previous processes of knowledge accumulation and learning that should be preserved by industries that have a non-codified knowledge component. Cohen and Levinthal (1990, 1996) argued that the long-run activity learning processes that firms acquire are difficult to transfer or acquire from elsewhere. Moreover, these learning processes have also themselves been subject to enormous transformations over the last three decades due to the presence of modern ICTs described above.

1.4 THE PROPERTIES OF KNOWLEDGE, TECHNOLOGICAL REGIMES AND THE EVOLUTIONARY FIRM

At the industrial level, the evolutionary literature has proposed that sectors and technologies differ greatly in terms of the knowledge base and learning processes related to innovation. Knowledge differs across sectors in terms of domains. One knowledge domain refers to the specific scientific and technology fields at the base of innovative activities in a sector (Nelson and Winter, 1982; Dosi, 1988). The second domain refers to the applications, the users and the demand for sectoral products. In addition, other dimensions of knowledge may be relevant for explaining innovative activities in a sector. Concepts such as accessibility, appropriability, opportunity and cumulativeness are argued to be key dimensions of knowledge. These are related to the notion of technological and learning regimes that differ across firms and sectors and help to understand why some firms benefit from their innovations while others do not capture the benefits of incurring R&D costs. Malerba and Orsenigo (1997) argue that different patterns of innovative activity in
a sector can be explained as the outcome of different technological regimes implied by the nature of technology and knowledge. The notion of technological regime provides a synthetic representation of some of the most important economic properties of technologies and the characteristics of learning processes involved in innovative activities. The main elements of the idea that patterns of innovative activities are related to technological regimes (Nelson and Winter, 1982; Malerba and Orsenigo, 1993, 1997) can be summarized as follows:

- Appropriability conditions reflect the opportunities on the part of knowledge investors for protecting their innovations from imitation by competitor firms, and the greater these opportunities, the higher the likelihood of the knowledge-investing firm capturing the maximum profits from its innovative activities (Nelson and Winter, 1982; Malerba and Orsenigo, 1993, 1997). Appropriability conditions are thus linked directly with the features and characteristics of the firm’s internal knowledge, and especially the degree to which this knowledge can be codified and standardized (Nelson and Winter, 1982; Malerba and Orsenigo, 1993, 1997). High appropriability conditions typically exist in the context where knowledge is both complex and difficult to codify, whereas low appropriability conditions reflect a business and economic environment characterized primarily by simple knowledge that can be easily standardized, routinized and codified (Nelson and Winter, 1982; Malerba and Orsenigo, 1993, 1997). In order to protect their innovations and knowledge investments, firms use a variety of different means, although the effectiveness and use of these different approaches tends to differ between industries according to the features of the knowledge. This, in turn, generally affects both the scale and the nature of knowledge externalities. Among the means employed to enhance appropriability are the use of patents, secrecy, lead-times, non-disclosure employment contracts, non-competition clauses, organizational arrangements and long-term contracts with employees, customers or suppliers (Nelson and Winter, 1982; Malerba and Orsenigo, 1993, 1997).

- Cumulativeness and progressiveness conditions in the resource-based view of the firm reflect the contribution that current innovations and innovative activities have as the springboard or the starting point for tomorrow’s innovations (Malerba and Orsenigo, 1993, 1997). The cumulativeness argument is that today’s innovative firms are more likely to innovate in the future in specific technologies and along specific trajectories, and this is especially the case if these firms experience internal learning processes and dynamic increasing returns at the technology level. Such cumulativeness driven by learning processes may be associated with organizational or human resource issues as much as with technological issues (Nelson and Winter, 1982; Malerba and Orsenigo, 1993, 1997).

- The knowledge base in the resource-based view of the firm refers to the properties of the knowledge upon which firms’ innovative activities are based. The nature and properties of the firm’s knowledge can be parsimoniously described according to the quatro-partite classifications of: generic versus specific knowledge; tacit versus codified knowledge; complex versus simple knowledge; independent versus systemic knowledge (Nelson and Winter, 1982; Malerba and Orsenigo, 1993, 1997). The innovation behaviour of the firm in response to these various knowledge...
characteristics is also heavily shaped by the means and agents of knowledge transmission and communication activities available to the firm (Nelson and Winter, 1982; Malerba and Orsenigo, 1993, 1997).

- The opportunity conditions in the resource-based view of the firm reflect the ease of innovating for any given amount of resources. Technological opportunity conditions are related to the characteristics of the market and environment in which firms operate, such as: barriers to entry; the nature of the innovation and the knowledge base internal or external to the firm and sector; the appropriability of the returns to knowledge investments; and the orientation of the innovation activities and systems.

The sources of technological opportunities, in other words, the varying ease of innovation across technological fields, differ across sectors (Scherer, 1965; Rosenberg, 1974). For example, Freeman (1992) and Rosenberg (1982) have shown that in some sectors the conditions governing opportunities are related to major scientific breakthroughs in universities. In other sectors, opportunities to innovate may come from advancements in R&D, equipment and instrumentation. Moreover, external sources of knowledge in terms of suppliers or users may play a crucial role. Not all external knowledge may easily be used and transformed into new products or services: in particular, if advanced integration capabilities are necessary in order to absorb this external knowledge (Cohen and Levinthal, 1990), then the industry is likely to be rather concentrated and dominated by large established firms. In contrast, if external knowledge is easily accessible and transformable into new products and services, then innovative entry into markets is likely to be widespread (Winter, 1984).

The cumulativeness of knowledge in terms of the degree to which the generation of new knowledge builds upon current knowledge (Nelson and Winter, 1982; Malerba and Orsenigo, 1993, 1997) also differs between industries. Cumulativeness at the technological and firm levels can create first mover advantages and tends to generate high levels of firm concentration. Regarding the sources of the cumulativeness of knowledge, three main ones can be identified (Nelson and Winter, 1982; Malerba and Orsenigo, 1993, 1997), namely: learning processes and dynamic increasing returns at the technology level; organizational capabilities that are firm-specific and can be improved only gradually over time; feedbacks from markets, such as success breeds success processes in which innovative success yields profits that can be invested again in R&D (Nelson and Winter, 1982). In general, a high degree of cumulativeness implies a high degree of appropriability. When returns to innovation remain largely with the knowledge-investor innovating firm, this encourages more internal R&D and innovation. In contrast, low cumulativeness and low appropriability on the part of the knowledge-investor reduces returns to internal R&D and incentivizes free-rider behaviour on the part of other firms (Nelson and Winter, 1982; Malerba and Orsenigo, 1993, 1997).

Malerba and Orsenigo (1997, 2000) analyse the relationship between technological regimes and the specific patterns of innovative activities in a sector. Knowledge that is accessible may be internal or external to the sector, and external knowledge in particular may be different in terms of its degrees of accessibility (Malerba and Orsenigo, 2000). This is important because greater knowledge accessibility decreases industrial concentration and monopoly power. This is in part determined by the nature of the knowledge
itself. The degree to which knowledge about an innovation varies between being tacit or easily codified also affects the ease of imitation and hence inversely reflects its level of appropriability on the part of the knowledge-investor. In particular, greater knowledge accessibility and appropriability by other firms implies low appropriability on the part of the knowledge-investor because competitors may more easily imitate the innovations of the knowledge-investing firm. Patents can in some cases be used to slow rivals’ imitation activities and generate internal profits. However, patents rarely confer strong appropriability to the innovator outside certain special cases such as new drugs, chemical products and rather simple mechanical inventions (Levin et al., 1987), and they are especially ineffective in protecting process innovations. The reason is that, ironically, the more complex a product, the easier it often is to re-engineer while introducing a number of incremental differences, thereby avoiding patent legislation.

The conditions under which the implications of cumulativeness and appropriability tend to diverge are when spillovers operate. Spillovers tend to be important where knowledge accessibility is high. As such, cumulativeness may exist at the level of the sector or the region even though appropriability at the level of the individual knowledge-investing firm may be low. Following this line of argument, the ways in which innovative activities take place in sectors, technologies, firms and regions may therefore be quite different (Iammarino and McCann, 2013). For example, in certain technologies innovative activities tend to be concentrated among a few major innovators, while in others they are distributed among larger numbers of firms. In some industries or in some regions large firms undertake the bulk of innovative activities, while in other sectors or regions small firms are very active. Meanwhile, in some regions innovation is dominated by firms that are highly clustered together whereas in other regions this is not the case.

For our purposes in this chapter, the technological regime approach is found to be especially useful for discussing the links between innovation and economic geography (Iammarino and McCann, 2013). Indeed, one of the most important ways for firms to enjoy returns from their knowledge investments is to protect their innovations, and as we have already seen, companies use different means for ensuring the cumulativeness and appropriability of their own knowledge investments and assets (such as patents, copyrights, trademarks or other forms of intellectual property, non-disclosure employment contracts and so on). These systems are essential in many contexts because if a firm’s knowledge and its diffusion are in part tacit and informal as well as complex and part of a larger system, the most relevant means of knowledge transmission is via face-to-face contacts and employment mobility of personnel. If, on the other hand, the firm’s knowledge is largely standardized, codified, simple and independent, the most relevant means of knowledge transmission are formal means, such as via routines, templates and blueprints. The former transmission and diffusion processes tend to be geographically constrained whereas the latter are not (Iammarino and McCann, 2013), and the characteristics of the knowledge will therefore have an influence both in the transmission of returns of knowledge investments into productivity gains and on the geography of firm behaviour (McCann, 2007). Taken together, the characteristics of knowledge – defined by notions such as its cumulativeness and appropriability, the degree of standardization or routinization of knowledge operations, and also the technological opportunities arising – provide a robust underpinning for discussing the links between innovation and economic geography. In particular, we can interpret the conditions under which clustering or
agglomeration is more advantageous than spatial dispersion from the vantage point of what types of knowledge are being generated, transacted or transmitted. Yet, quite how these interrelationships play out and exactly how they are to be understood requires us to reinterpret these approaches in an explicitly geographical setting. These are the issues to which we now turn.

### 1.5 ECONOMIC GEOGRAPHY, INNOVATION, KNOWLEDGE SPILLOVERS

There is a large literature on the geography of knowledge and spillovers. Jaffe (1986, 1988; Jaffe et al., 1993) was one of the first to examine the effects of knowledge spillovers between firms, finding in general that in the United States patents are likely to be cited by firms at a location close to the inventor, while cross-border citations are less likely than domestic citations. As such, certain types of knowledge spillovers are taken to be geographically bounded (Moretti, 2004). Indeed, widespread subsequent evidence also supports the idea that knowledge spillovers, where they exist, are mediated via geography, the more tacit the knowledge, the more spatially concentrated its spillovers. An additional aspect of clustering common to all forms of clusters is that local competition and mutual visibility also foster imitation and innovation (Porter, 1990). Innovation and entrepreneurship are therefore often associated with cities (Acs, 2002), and evidence from the United States also suggests that regions that are more sectorally diversified (Glaeser et al., 1992) and structurally disaggregated (Duranton and Puga, 2001) exhibit higher knowledge spillovers, although the international evidence on this is not at all clear-cut (Beaudry and Schiffauerova, 2009; De Groot et al., 2009; De Melo et al., 2009). In particular, the European context appears to be rather more mixed than the United States, with neither specialization nor diversity playing a decisive role in the geography of growth and innovation (De Groot et al., 2009). Similarly, although there is some evidence that cities exhibit higher rates of entrepreneurship and innovation, there is also a great deal of heterogeneity across European observations (Sternberg, 2011). In addition, as well as the links between industry structure and geography, other researchers have studied knowledge interactions between firms and universities or research institutes (Anselin et al., 1997; Mansfield, 1965; Darby and Zucker, 2003; Adams, 2004), and again evidence points to localization effects of knowledge spillovers (Jaffe et al., 1998; Adams et al., 2003), although the nature and magnitude of these effects appear to vary significantly as the nature of university linkages with the wider economy range from human capital-mobility effects (Faggian and McCann, 2009) to R&D activities. While the available econometric evidence is broadly – but only weakly – supportive of these knowledge- and innovation-related localization, clustering and agglomeration arguments, there are still numerous exceptions to these trends. Following the cumulativeness and appropriability arguments, spatial dispersion rather than spatial concentration will often be an appropriate strategy in cases where firms prioritize secrecy. In order to avoid knowledge spillovers many highly innovative firms working at the frontiers of technology have major knowledge facilities located in relatively isolated locations (Simmie, 1998) or they used corporate organizational structures and legal systems to enforce secrecy (Arita and McCann, 2002; Arita et al., 2002).

Part of the problem here is that industrial clustering of activities does not necessarily
imply that widespread local knowledge spillovers are evident. The knowledge-related arguments discussed above imply that innovation that is heavily driven by local knowledge spillovers will only in reality be evident in certain circumstances and where certain knowledge-related conditions are fulfilled. As such, our argument goes somewhat against the standard agglomeration-spillover assumptions popular in urban economics, which often treat agglomeration and clustering as independent evidence of the widespread existence of such spillovers. Indeed, we argue here that the links between knowledge, innovation and economic geography are in reality more complex than the ‘learning, sharing, matching’ (Duranton and Puga, 2004) assumptions widely advocated. Indeed, from the arguments outlined above we may ask: learning about what? sharing what? matching what? We can learn about knowledge, we can share knowledge, we can match knowledge; we can learn about technology, we can share technology, we can match technology; we can learn about human capital, we can share human capital, we can match human capital. Moreover, we can apply these arguments to other issues, such as, for example, organizational systems, which can be shared, matched and learned about. Indeed, these arguments could be extended to institutional systems, training systems, financial systems, marketing systems, transport systems, legal systems. The list goes on, but importantly for our purposes here, these various learning, sharing and matching processes are likely to differ substantially depending on what is being learned, shared or matched. As such, the geographical advantages or disadvantages of clustering or agglomeration are likely to differ substantially depending on the issues at hand, and clustering or agglomeration cannot be taken itself as de facto evidence of the existence of knowledge spillovers.

One of the key reasons why knowledge spillovers and clustering are not synonymous is that while clustering offers possible benefits from inward knowledge spillovers, it also implies costs associated with outward spillovers. Clustering increases knowledge accessibility and appropriability on the part of other firms via spillovers, while at the same time reducing knowledge cumulativeness and appropriability of the firm making knowledge investments. Therefore, while, on the one hand, the arguments favouring clustering and agglomeration are based on the premise that clustering allows for knowledge spillovers in a form that largely provides a common public good, on the other hand, the arguments of Grindley and Teece (1997) imply that firms must always consider the costs associated with unintended knowledge outflows. In other words, the problem associated with the inability of the firm to earn maximum returns to internal investments due to unintended knowledge outflows means that in a cluster it must either find ways to protect its knowledge investments by inhibiting knowledge spillovers or by relocating away from a cluster. In some cases, firms use legal and organizational strategies to limit knowledge spillovers, and the greater the degree of clustering, the greater the need for such strategies. In some cases, these legal and organizational systems will be used in tandem with dispersed location strategies, particularly in cases where utmost secrecy is essential for the firm’s technological progress.

Following on these arguments, and building on the earlier work of Gordon and McCann (2000) and McCann and Mudambi (2004, 2005), Iammarino and McCann (2006) develop a Pavitt (1984)-type classification of different types of industrial clusters – namely, pure agglomeration, industrial complexes and social networks – based on their innovation and knowledge characteristics. This classification is then extended and updated (Iammarino and McCann, 2013) to allow for different types of social networks.
The Iammarino and McCann (2006, 2013) approach argues that clustering primarily associated with local knowledge spillovers, in the sense of externalities, occurs in situations of pure agglomeration in which markets are largely: monopolistic and stochastic in nature; knowledge exhibits low cumulativeness and appropriability; and external sources of market-based knowledge dominate. These situations are most relevant where knowledge is diversified and broadly based and also largely codified into information. They are evident in many types of service industries. These cases tend to be supplier dominated and while the technological opportunities vary, technological trajectories tend to be primarily related to problem-solving processes and organizational innovations.

In contrast, where local industries are primarily oligopolistic, knowledge transactions within industrial complexes are mediated via long-term legal contracts between groups of firms: the benefits of these knowledge exchanges remain internal to the group of firms. This allows all firms in the group to appropriate all of the rents associated with their internal investments and to maximize returns to their R&D, much of which is focused on basic science. Knowledge spillovers, in the sense of pure externalities, are almost entirely absent, and the knowledge base is specialized, narrow and focused on complex products and cost cutting, although firms do benefit from innovations embodied both in intermediate demand and also in the R&D investments of other firms in the group. Levels of cumulativeness and appropriability are high, and industry dynamics are strategic rather than stochastic in nature, since the routinized and specific activities internal to the firm are primarily governed by hierarchies rather than markets. These spatial-organizational arrangements are typical in sectors such as petro-chemicals, pharmaceuticals and automobiles, as well as in the ICT hardware products and the medical instruments sectors.

Some spatial-organizational arrangements are primarily mediated via social networks: these tend to be of two types, namely, trust-based or competence-based. These knowledge spillover systems operate either on the basis of a shared longstanding history, a ‘community of practice’ that gives rise to trust-based relationships – typical in many traditional craft-based, touristic and heritage industries – or in the rather newer social network systems based on cognitive relations typical in high-technology clusters of SMEs, where tacit knowledge flows via informal exchanges between firms (Von Hippel, 1994). The science-driven knowledge base in competence-based networks tends to be broader than the more specialized and traditional knowledge base of trust-based networks. However, in both cases social bonds foster reciprocal and frequent face-to-face contacts: physical proximity may often facilitate knowledge transmission, and these proximity effects are especially important in trust-based networks. All social networks exhibit low levels of appropriability, and sources of innovation tend to be external to the firm. Yet, there are also major differences between the innovation characteristics of these two types of social networks. The degree of cumulativeness is low in competence-based networks, and the uncertainty and disruption involved in radical new product development mean that the innovation and technological opportunities tend to be high. In contrast, in trust-based networks that are primarily incremental and process driven, technological opportunities are low as levels of knowledge cumulativeness are high.

These knowledge-related lines of enquiry allow us to make sense of many different types of spatial organization. Moreover, they allow us to make sense of situations where firms will disperse or will disperse various functions. We may safely assume that all firms enjoy experiencing inward knowledge spillovers, and all else being equal this supports a
tendency towards clustering. However, we also know that many firms are keen to avoid unintended outward knowledge spillovers, as these may undermine the cumulativeness and appropriability of their internal knowledge assets. To partially counter such threats, spatial dispersion makes sense. Spatial dispersion also makes sense in situations where a firm’s markets are themselves dispersed or where a firm wishes to use location as a means to access new knowledge. However, in either of these cases spatial dispersion is still only viable where the firm is able to use organizational, technical or legal systems to ensure the cumulativeness and appropriability of its own internal knowledge while it is transacting knowledge across large spatial distances. Indeed, the provision and operation of such organizational, technical and legal systems designed to prevent knowledge outflows and maintain the appropriability and cumulativeness of knowledge are the specialist preserve and raison d’être of multi-plant and, in particular, multinational firms (Iammarino and McCann, 2013).

At the same time, these systems are used to enable such firms to cluster while limiting or inhibiting unintended outward knowledge spillovers. More specifically, if sufficient protection against unintended outward knowledge spillovers is available, then a firm will be able to make knowledge-related location decisions on the basis of the ongoing transactions costs associated with face-to-face interactions (McCann, 2007), weighed against classical location-specific factor cost considerations. These decisions will relate to, for example, the siting of individual facilities relative to core central business districts, or alternatively to the location of various multi-plant and multinational facilities in different locations. In such situations, the ongoing costs and opportunity costs of face-to-face interactions, whose importance to the firm depends on the degree of standardization of the knowledge being acquired, can be analysed in a manner consistent with orthodox location theory. On the other hand, if firms are unable to ensure the cumulativeness and appropriability of their knowledge investments, then their location strategies will tend towards patterns of spatial dispersal rather than clustering and concentration.

1.6 CONCLUSIONS

The arguments and analysis outlined in this chapter suggest that in terms of underpinning innovation processes, the observation of agglomeration and geographical clustering only makes sense under certain knowledge conditions. On the one hand, where the knowledge base is distributed and where the knowledge itself displays both low appropriability and low cumulativeness, then agglomeration-related behaviour is indeed suggestive of local knowledge spillovers. On the other hand, in other knowledge-related conditions, industrial clustering does not necessarily imply the existence of local knowledge spillovers, and other explanations must be sought for such spatial behaviour. As such, the common approach adopted in many urban economic studies, whereby the observation of spatial clustering is taken itself as de facto evidence of knowledge spillovers, cannot be upheld unless other empirical evidence is also available to substantiate these claims. Firm-specific microeconometric evidence is ideally suited to play this role, and the available micro-survey-based evidence that is emerging from various countries does not point unequivocally to these simple local spillover-learning narratives (Shearmur and Doloreux, 2008, 2013; Simonen and McCann, 2008, 2010; Doloreux and Shearmur,
As consistent with the different issues raised in this chapter, the relationships between innovation, knowledge spillovers and geography are complex and varied and depend on the nature and roles of the knowledge being generated and transacted. In addition, there are also other debates regarding the extent to which knowledge and innovation is context-dependent or otherwise (Shearmur, 2011; Barca et al., 2012), although these are issues for another analysis.

NOTES

1. Evidence in support of this argument also comes from Cassiman and Veugelers (2006) who conducted pioneering work addressing the complementarity between R&D activities and its context. They argue that complementarities do exist between internal R&D and external knowledge acquisition, although the channels via which complementarities operate are firm-specific and context-specific. Later research tried to deepen the discussion suggested by Cassiman and Veugelers (2006) by subdividing corporate R&D. Schmiedeberg (2008) divided R&D activities into three categories: internal R&D, R&D cooperation and R&D contracting, and found empirical evidence that strongly indicates complementarities between internal R&D and R&D cooperation. Catozzella and Vivarelli (2007) included in-house and commissioned R&D, and embodied and disembodied technological acquisition. They stressed the catalysing role of in-house R&D and showed that internal R&D is complementary to all other innovation activities.

2. Los and Verspagen (2000) introduce the notion of indirect R&D available to the firm, by taking the unweighted sum of all other firms’ R&D stocks (Bernstein, 1988). The idea behind this is that technology produced by some firms is more relevant than that produced by other firms. Many firms nowadays derive benefits from different external R&D sources by following an ‘open’ innovation model (Chesbrough, 2006), and therefore in order to capture these complementarity effects other approaches have been developed. Limiting inter-industry rent effects to technology, Terleckyj (1974), Siekhauskas (1981), Wolf and Nadiro (1993) and others utilize input-output or capital flows matrices to construct weights assuming that an industry that buys relatively more from a certain industry will benefit relatively more from (product-oriented) R&D in that industry. A related approach is chosen by Griliches and Lichtenberg (1984), Sterlacchini (1989) and Mohren and Lepine (1991), who use matrices in which either patents or innovations are classified according to their industry of manufacture and origin of use, using the patent indicator as a measure of rent spillovers.

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2. Regional innovation systems: past – present – future

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2.1 INTRODUCTION

There is widespread consensus in academic and policy debates that knowledge and innovation are eminently important for securing competitiveness, dynamic growth and prosperity of regional economies. The regional innovation system (RIS) approach figures prominently in scholarly discussions about the uneven geography of innovation and the factors that shape the knowledge generation and innovation capacities of regions. Since its development in the 1990s, it has attracted considerable attention from economic geographers and innovation scholars. Protagonists of the RIS notion have convincingly argued that the question of geographical scale is essential for understanding new knowledge creation and its economic exploitation.

This chapter reviews and discusses the conceptual cornerstones of the RIS notion and takes stock of some of the core contributions made by the pioneers of this approach. Section 2.2 offers an overview on the antecedents of the RIS approach and its theoretical foundations, exploring the grounding of the concept in the innovation systems literature and its connections to other territorial innovation approaches. In Section 2.3 we discuss scholarly work on the variegated nature of regional innovation and the typologies that have been suggested to grasp the sources of differences in innovation capacity across regions. This is followed by an assessment of the attempts that have been made to apply the RIS concept to developing countries and regions and cross-border areas. This chapter also contains a review of the conceptual advances offered by the knowledge base approach, which has led to a significant further development of the RIS literature in the past decade. Furthermore, the notion of RIS as open systems and its links to the debate on the nature and geography of knowledge flows that underpin the innovation dynamics of regions are discussed.

Section 2.4 sheds light on the role of public policy and takes account of the inputs provided by the RIS literature to the discussion about the nature of modern innovation policy approaches. We demonstrate that the RIS notion has substantially informed this debate, providing a framework for designing and implementing regional innovation strategies across the globe and paving the way for customized, broad-based innovation system policies. Finally, Section 2.5 seeks to identify some of the most important current and future lines of research on RIS. We argue that in particular recent foci on the capacity of RIS to support new regional industrial path development and the transformation of RIS themselves as a precondition and consequence of regional industrial change deserve more attention in future work.
2.2 ORIGINS OF THE RIS CONCEPT AND ITS THEORETICAL FOUNDATIONS

The RIS concept appeared in the 1990s and has since then attracted widespread interest from scholars and policy makers alike (Cooke, 1992, 1998, 2001; Cooke and Morgan, 1994; Asheim, 1995; Asheim and Isaksen, 1997, 2002; Autio, 1998; Howells, 1999; Doloreux, 2002; Asheim and Gertler, 2005). The RIS concept combines insights from the literature on innovation systems (Lundvall, 1992; Nelson, 1993; Freeman, 1995; Edquist, 1997) with the simultaneously burgeoning contributions on territorial innovation models (Moulaert and Sekia, 2003). The theoretical antecedents of RIS concepts are discussed in two sub-sections below, zooming in on the innovation system approach as well as the reasons why a regional perspective on innovation systems is still legitimate and relevant.

2.2.1 Innovation System Approach

The innovation system approach was born in an Organisation for Economic Co-operation and Development (OECD) project on ‘Science, Technology and Competitiveness’ in the beginning of the 1980s. It builds on the premise that innovation is the key for competitiveness in a knowledge economy. Moving away from price competition and a focus on comparative advantages, the future for advanced economies was seen in introducing new and improved products and processes, organizational routines and marketing strategies by promoting increased learning and innovation capacity. Innovation, interpreted in a Schumpeterian sense, was given highest priority in order to promote the recombination of knowledge and resources in novel ways that create higher value.

Innovation, however, was long perceived as a linear process where input in research and development (R&D) leads to new inventions that are then commercialized. The innovation system approach moves away from a linear model and recognizes that innovation typically results from complex, interactive and cumulative knowledge and learning processes in which a variety of actors participate. Clearly, investments in R&D will not stimulate economic growth if the generated knowledge cannot be appropriated by firms and translated into, for instance, products and processes that are introduced to the market. Furthermore, not all innovation, nor all competitive advantage based on product differentiation and Chamberlinian monopolistic competition, are the result of R&D. Innovation is far more varied and can be based on learning by doing, using and interaction (DUI) as well as on science and technology (STI) (Jensen et al., 2007).

The innovation system approach thus recognizes that innovation comes in multiple forms and results from interdependencies between a variety of actors. This new understanding of innovation had profound policy implications. Innovation policy should not emphasize primarily the strengthening of R&D capacities but also support the circulation of knowledge between all the actors that are involved in generating innovations. This requires a shift of the policy focus from a few selected types of actors towards a broader approach that pays particular attention to the networks between, for instance, universities, research organizations and firms, as well as to the institutional environment in which these interactions are embedded. An active policy push is required not only to correct market failures but also promote the functioning of the system, that is, knowledge exchange and learning between actors.
At the same time, innovation systems have always been viewed as open systems. This is because economies are not self-sustaining in the generation of knowledge. Economies, technologies and related institutions constantly evolve in all parts of the world. Ignorance of this fact and potential sources of new variety created elsewhere would sooner or later turn any closed innovation system into a dinosaur. The dynamics of innovation systems therefore depend on actors that are able and willing to tap into globally distributed knowledge sources. The absorptive capacity of actors in innovation systems, however, is to a large extent determined by the quality of human capital and organizational competencies, which in turn is influenced by the regional and national knowledge infrastructure such as universities and the education system. It can be argued therefore that competitiveness in the knowledge economy depends on the configuration of, and interdependencies in, innovation systems, on a high degree of openness, and on the intersections between innovation systems and global innovation networks.

2.2.2 Regional Innovation Systems

Simultaneous with the emergence of the innovation system approach in the 1980s, the concept of industrial districts was rediscovered and used to explain the success of post-Fordist regions characterized by flexible production systems and tight inter-firm networks giving rise to external economies of scale (Brusco, 1982; Pyke et al., 1990; Asheim, 2000). It was a revival of Marshall’s (1920) ideas on the importance of local and regional context for the exchange of knowledge, the development of a local labour market and supplier industries. A large body of related work contributes to unveiling how regional context shapes innovation performance, including research on learning regions (Asheim, 1996), innovative milieu (Camagni, 1995; Maillat, 1998; Crevoisier, 2004) and clusters (Swann and Prevezer, 1996; Baptista and Swann, 1998; Porter, 1998, 2000; Maskell, 2001).

Common to these territorial innovation models (Moulaert and Sekia, 2003) is a systemic perspective according to which innovation results from interactive learning processes between different types of actors. The systems approach therefore offers a unifying framework for these models despite the specificities of each (Asheim et al., 2011c). Innovation systems are by definition open systems (see above), which raises the question of how to delineate innovation systems and how to draw boundaries. The rationale for applying a system perspective at the regional level lies in particular in the importance of geographical proximity for knowledge exchange and interactive learning as well as in the region’s meso-level governance role.

The RIS approach emphasizes the importance of geographical proximity for knowledge transfer and learning and thereby legitimizes the regional perspective on innovation systems. Knowledge is partly tacit and thus difficult to transfer over distance (Polanyi, 1958). Malmberg and Maskell (1999, p. 180) maintain that the proximity argument relates to ‘the “time geography” of individuals. Everything else being equal, interactive collaboration will be cheaper and smoother, the shorter the distance between the participants.’ Furthermore, tacit knowledge is embedded in a social, cultural and institutional context and, as Gertler shows in his empirical investigation of German manufacturers operating in the USA, tacit knowledge may lose its value when applied in other contexts (Gertler, 2004). Geography is also important due to the spatial bias of social networks facilitating
the circulation of knowledge (Granovetter, 1973, 2005). The main reason for the spatial bias is that geographical proximity is important to establish social networks (Agrawal et al., 2006). This is intensified by the low mobility of labour. Breschi and Lissoni (2009, p. 460) find evidence that ‘[t]he fundamental reason why we observe geographical localization of patent citations is the low propensity of a special category of knowledge workers and providers of knowledge-intensive services (the inventors) to relocate in space’. Furthermore, the dominant geographical scale for sourcing knowledge through recruitment is regional (Grillitsch et al., 2013; Plum and Hassink, 2013).

The region often also represents an important level of governance situated between the local and municipal level, as well as the national and the international level. According to Howells (1999, p. 72), three dimensions define the importance of the regional level, namely: ‘1. the regional governance structure, both in relation to its administrative set-up and in terms of legal, constitutional and institutional arrangements; 2. the long-term evolution and development of regional industry specialization; and 3. additional core/periphery differences in industrial structure and innovative performance.’ The relative independence and strength of regional government like in Austria or Germany, or the weakness of national government like in Italy can be important drivers for the emergence of RIS (Asheim and Isaksen, 1997). The success of Baden-Württemberg’s technology policy was to a large extent contingent on the federalist form of governance in Germany, which provides for independence, resources as well as high competencies of the regional government. However, even without legislative autonomy and funding opportunities, regions can play an important role in coordinating innovation activities and supporting the local industry, exemplified by Emilia-Romagna in Italy (Bianchi and Giordani, 1993).

Consequently, an innovation system perspective is often justified at the regional level. This, however, does not yet tell us much about what RIS actually are. RIS understood in a narrow sense comprise two sub-systems, one capturing actors exploring and generating new knowledge and another encompassing firms engaged in the exploitation of innovations. The knowledge exploration sub-system typically refers to universities, public and private research organizations, technology mediating organizations, workforce mediating organizations and educational organizations. The knowledge exploitation system relates to firms, often organized in one or several clusters potentially with horizontal networks between competitors and collaborators and vertical networks along the value chain. In a broad sense, RIS encompass all regional economic, social and institutional factors that affect the innovativeness of firms (cf. Lundvall, 1992). The broad perspective views the two sub-systems as being embedded in an institutional and organizational support infrastructure for innovation (Autio, 1998; Cooke, 1998; Tödtling and Trippl, 2005; Asheim, 2007).

Moreover, RIS are systemic due to the networks and interactions between the actors. Hence, it is questionable to speak of a regional innovation system if regional actors do not interact within and between the two sub-systems. These interactions are perceived as socially embedded. Thus, the two dimensions of social capital, that is, social networks and shared norms, values and a culture of trust (Putnam, 1995; Burt, 2000), are assumed to contribute to interactive learning and thus to the functioning of RIS. Accordingly, the regional innovation system approach places a stronger emphasis on informal institutions than the national variant. However, common to both, the national and regional innova-
tion system approaches, is the central role of innovation policy for shaping the conditions for innovation and thus for constructing regional advantage (Asheim et al., 2011b; Tödtling et al., 2013a).

From the above, a clear distinction can be made between the RIS approach and its antecedents like industrial districts, innovative milieus or industrial clusters. From the start, these concepts zoomed in on interrelated firms in one or related industries that are co-located in space. As the cluster literature evolved, the importance of knowledge exploration to promote innovativeness has surfaced. The RIS approach, however, is more general and encompassing insofar as it looks at the systemic integration of these elements in a region, including the institutional and organizational support structures. A RIS furthermore can capture one (for example, in a specialized region) or a variety of clusters in different stages of development (Trippl and Tödtling, 2008). This implies, furthermore, that RIS are arguably more relevant units of analysis for structural change (even if the existing literature often suffers from a static perspective) than, for instance, industrial clusters. The reason is that new path development often results from the combination of related or unrelated industries, knowledge bases and economic activities, thus from combinations that transcend cluster boundaries, as we shall discuss more in Section 2.5.

2.3 CONTRIBUTIONS OF THE RIS APPROACH TO INNOVATION STUDIES AND ECONOMIC GEOGRAPHY

Over the past two decades, a flourishing literature on RIS has made essential contributions to the fields of innovation studies and economic geography. In this section we identify and discuss several of the most important core themes.

2.3.1 Types of RIS

The RIS approach has essentially contributed to a better understanding of the uneven geography of innovation. Its advocates have offered rich explanations for the sources and dimensions of the variegated nature of regional innovation, that is, why and in what respects innovation activities differ between regions. These endeavours have been accompanied by the development of a number of RIS typologies. The dimensions according to which RIS typologies were developed focus on (1) key actors and governance (Cooke, 1998; Asheim and Isaksen, 2002); (2) the strengths in radical versus incremental innovations (Cooke, 2004); and (3) RIS failures (Isaksen, 2001; Tödtling and Tripl, 2005).

The typologies of Cooke (1998) and Asheim and Isaksen (2002) are based on the actors and modes of governance constituting RIS. In ‘grassroots RIS’ or ‘territorially embedded RIS’ innovation is driven by geographical proximity and interactions of firms located in the region. Typical examples are the Italian industrial districts, dominated by small firms that compete through flexible forms of production often in traditional industries. Governance is largely bottom-up, embedded in the social networks of the local actors. In ‘regionally networked innovation systems’ linkages between firms, R&D bodies and other supporting organizations can be observed and are often organized in deliberate ways. Such RIS are characterized by multi-level governance with a strong involvement of the regional level like in Baden-Württemberg. ‘Dirigist RIS’ or ‘regionalyzed national
innovation systems’ differ substantially from the other two types. Localized learning and geographical proximity are less relevant. Firms mainly benefit from knowledge provided by national and international organizations as well as from proximity to universities and research institutes. Thus, while the first two RIS types draw to a large extent on endogenous development potential; the third one builds more on an exogenous development model. Furthermore, local and regional levels of governance play a substantially smaller role than national and international levels.

RIS scholars have also engaged in efforts to explain why some regions are able to generate high rates of radical innovation while others appear to do much better in producing innovations that are more incremental in nature. These differences have been portrayed as the outcome of particular RIS configurations referred to as institutional RIS (IRIS) and entrepreneurial RIS (ERIS) (Cooke, 2004). IRIS are well suited to promote incremental innovations in traditional sectors due to system features such as strong user-producer interactions, supporting regulatory and institutional frameworks, public investment in (applied) R&D, the prevalence of patient capital and longer-term perspectives of a broad group of stakeholders. ERIS, in contrast, offer good conditions for radical innovation and new industries to flourish. Their dynamism is based on (local) venture capital, entrepreneurship, scientific excellence, market demand, (local) venture capital and short-term profit boosting of shareholders. The distinction in ERIS and IRIS shares some striking similarities with the varieties of capitalism approach and its distinction between liberal and market economies (Asheim and Coenen, 2006; Asheim, 2007) and regional versions of it (Ebner, 2015). Furthermore, Asheim and Coenen (2006) argue that the national institutional framework has a strong impact on the development of RIS. They argue that ERIS prevail in liberal market economies such as the USA and the UK while IRIS are more common in coordinated market economies like Germany or the Scandinavian countries.

Another important argument brought forward in the RIS literature is that different types of regions often face typical systemic challenges (Isaksen, 2001; Tödtling and Tripl, 2005). A distinction has been made between metropolitan agglomerations, old industrial regions and peripheral regions. Agglomerations are usually well endowed with a variety of organizations contributing complementary knowledge to innovation processes such as firms, universities, educational facilities, public innovation support facilities and policy makers. Also, different industries, building on different knowledge bases, are present. Headquarters of large organizations are usually located in cities, and with them knowledge-intensive business services. Agglomerations are thus well equipped for combining different types of knowledge and consequently innovate. A typical system failure for agglomerations, however, is fragmentation, which relates to a lack of networks and knowledge exchange between different sub-systems of the innovation system, such as between firms and universities (Fritsch, 2003). Peripheral regions, in contrast, typically face the system failure of organizational thinness, that is, too few organizations that could stimulate the above-mentioned localized learning processes. In particular, such regions depend on external networks in order to compensate for lack of learning opportunities locally (Fitjar and Rodriguez-Pose, 2011; Tödtling et al., 2012; Grillitsch and Nilsson, 2015). Finally, specialized regions, with strong organizations in a specific industry and an institutional framework supporting specialization, may face difficulties in adapting to changes in market or technological conditions. Thus, former
success factors may become constraints and create negative lock-ins, a typical system failure in specialized regions (Tödtling and Trippl, 2004; Hassink and Shin, 2005; Trippl and Otto, 2009).

### 2.3.2 Applications of the RIS Approach to Other Contexts

The RIS approach has also been applied to a variety of macroeconomic contexts comprising the Global North and South, and lately also to cross-border areas. This has led to some extensions and reconceptualizations of the notion. There are several aspects that surfaced from this literature: (1) how to understand incomplete or emergent RIS; (2) how and why RIS emerge and strengthen over time; and (3) how to compare RIS across fundamentally different institutional and economic contexts.

In emerging and developing countries in particular, it may be questioned whether RIS exist. Important elements of the RIS may be missing such as capable organizations in the knowledge exploration or exploitation sub-systems, the regional actors may be poorly networked and institutions may rather constrain than foster innovation. Accordingly, Radosevic (2002) was dubious as to whether RIS could be observed in Central and Eastern Europe and suggested that the key focus should be on factors determining the emergence of RIS, which according to him depends on the interplay between national, regional, micro-specific and sector-specific determinants. Against the backdrop of post-socialist transformation at the regional level, RIS should be analysed from a multi-level perspective. Evidently, even though Radosevic concludes that Central and Eastern European countries still have a formidable task ahead to establish strong RIS, the approach has been useful to identify the systemic deficiencies that hamper innovation, which relate less to the presence of RIS organizations and more to their quality and local collaborative networks.

The value of a more dynamic application of the RIS approach has also been underlined for developing countries (Asheim and Vang, 2006; Chaminade and Vang, 2008), which closely resonates with current efforts to introduce a more dynamic perspective to the RIS literature, as discussed in Section 2.5. In developing countries, RIS typically are characterized by the low level of capabilities of indigenous firms, of labour, but also of knowledge generating organizations such as universities and research organizations. Thus, RIS located in the global periphery depend to a large extent on the inflow of knowledge, human and financial capital from external sources, such as through multinational corporations. Typically, it is understood that firms in RIS perform low-value activities and thus compete on factor cost and could in the best case be understood as specialized hubs in global value chains.

The crucial question then is how innovation policy can support the development of traded and untraded interdependencies (Storper, 1995) between indigenous firms and subsidiaries of multinational corporations, and enhance local absorptive capacity. However, the picture might also be more blurred, as even in the global periphery there might be some strong firms that trigger foreign direct investments and could be the source for further upgrading (Mudambi and Santangelo, 2015). Hence, more research on these dynamics is certainly required.

The RIS approach and the typologies that have been developed, as outlined in the previous sub-section, have also proved valuable in different contexts and for the purpose of
comparing regions located in substantially different institutional and economic context conditions. For instance, Blazek and Zizalova (2010) apply the typology to Prague. The metropolitan area of Prague is described as fragmented, but they find that the RIS is in itself very diversified with some elements being fragmented while the biotechnology industry, one specific cluster within the RIS, is well networked. Tödtling et al. (2013b) compare the role of the information and communications technology (ICT) sector in renewing two RIS dominated by traditional industries but embedded in different national contexts, concretely Austria, as an advanced high-income market economy, and the Czech Republic, which transformed from a state planned to a free market economy in the early 1990s. The article shows how the configuration of networks, organizational capabilities and innovation performance interacts with the national contextual conditions. Chaminade (2011) uses the RIS approach to investigate the geography of knowledge flows in the Great Beijing region in China and Pune in India for the automotive and software industries. Her main finding is that networks differ more between regions than between industries, thus underlining the importance of geographical context. However, Chaminade (2011) also points out that the demand side of innovation, as well as firm strategy, have received too little consideration.

The RIS concept has also been applied to cross-border areas (Trippl, 2010; Lundquist and Trippl, 2013), that is, to regions that are made up of adjacent territories that belong to different nation states. Well-known examples are the Öresund region (situated at the intersection of Denmark and southern Sweden), the Euroregion (Aachen, Liege, Limburg) and the Centrope area (consisting of two capital cities Vienna and Bratislava, and neighbouring regions in Austria, the Czech Republic, Slovakia and Hungary). Various factors, most notably regionalization processes across the globe, the political and economic transformation of former communist countries and the enlargement of the European Union, have led to a rise in importance of cross-border regions, challenging the exclusive focus on RIS situated within a single national context. Scholarly work on cross-border RIS has thus far devoted particular attention to investigating critical preconditions for the emergence of integrated innovation spaces in trans-border settings and identifying various stages of their evolution. Lundquist and Trippl (2013) advanced the idea that the rise and dynamic development of cross-border RIS requires a reduction of distance across various dimensions, ranging from cognitive, functional, social and institutional ones. Empirical studies have given particular emphasis to the latter aspect, that is, to the institutional dimension. Departing from a broad definition of institutions that includes both formal institutions (such as laws and regulations) and informal institutions (like norms, values and routines), various scholars have found that many cross-border regions feature high levels of institutional distance, providing evidence that the lack of a common language, shared trust, beliefs and values, a common law system and so on often form powerful barriers to innovation-driven integration processes in trans-boundary regions (Van Houtum, 1998; Krätke, 1999; Hall, 2008).

2.3.3 Knowledge Bases

Innovation processes involve the novel combination of knowledge and have become increasingly complex and open. This is reflected in, on the one hand, a large body of literature dealing with the different types of knowledge involved in innovation processes and,
on the other hand, in contributions scrutinizing knowledge flows within and between organizations.

Moving beyond the dichotomy of tacit versus codified knowledge as well as the focus on scientific knowledge, upon which the linear view of innovation is grounded, the differentiated knowledge base approach has been an important advance in the RIS literature (Asheim and Gertler, 2005; Tödtling et al., 2005; Asheim, 2007). This approach builds on an ontology that consists of three innovation-relevant knowledge types: analytical, synthetic and symbolic knowledge. The knowledge types differ in the way knowledge is created, who is involved in the knowledge creating processes, the importance of tacit versus codified knowledge, as well as what types of innovations are created.

The analytical knowledge base draws largely on scientific knowledge created through deductive processes and formal models. Much of this knowledge is codified, for instance, in patents or research publications. Innovations bring new knowledge to the market resulting from collaborations between firms and research organizations. In contrast, applied, problem-related (engineering) knowledge is at the core of a synthetic knowledge base. New knowledge is typically created through inductive processes stimulated by interactive learning processes often involving clients or suppliers. Tacit knowledge plays an important role as more concrete know-how, craft and practical skills are transmitted. Innovation is more incremental and result from the application or novel combinations of existing knowledge. Symbolic knowledge represents the ability to understand and interpret the habits and norms of popular culture. Innovations result from the creation of meaning and desire through the generation of new designs, aesthetics and intangible, cultural attributes of products. This type of knowledge exhibits a high cultural embeddedness and is typically created by exchange in informal and professional communities, often in a local context.

The differentiated knowledge base literature has shown that the relative importance of each knowledge base varies significantly across industries and regions (Plum and Hassink, 2011; Aslesen and Freel, 2012; Martin, 2012). Moreover, the geography of innovation differs markedly depending on the dominant knowledge base (Moodysson et al., 2008; Martin, 2013; Herstad et al., 2014). While the transfer of analytical knowledge appears to be least restricted by geographical distance, symbolic knowledge is most sticky, which has to do with the relative importance of tacit and codified knowledge as well as the cultural and institutional embeddedness of knowledge (Gertler, 2003). Recently, the focus shifted from industry and region-level analyses towards firm-level studies and innovation biographies showing that innovations, and in particular the more radical innovations, are often the result of combinations of knowledge bases (Manniche, 2012; Strambach and Klement, 2012; Grillitsch and Tripl, 2014; Tödtling and Grillitsch, 2015).

### 2.3.4 RIS and the Geography of Knowledge Flows

The RIS approach was inspired by examples of successful regions with strong endogenous development potential, interregional networks embedded in an institutional environment conducive to knowledge exchange and interactive learning like Emilia-Romagna (Piore and Sabel, 1984), Baden-Württemberg (Cooke and Morgan, 1994) or Silicon Valley (Saxenian, 1994). This, however, should not hide the fact that RIS have always been conceptualized as open systems. Systems that are embedded in national innovation
systems, linked to other RIS, and that overlap with technological systems of innovations (Carlsson and Stankiewicz, 1991; Markard and Truffer, 2008) and sectoral systems of innovation (Malerba, 2002, 2005). Well-developed RIS are characterized by strong embeddedness and networks within, but also with actors located outside, the region.

Theoretically, this idea has been captured by discussions of the different dimensions of proximity (for a literature review, see Knoben and Oerlemans, 2006). Geographical proximity facilitates face-to-face meetings, which play an important role for interactive learning processes; tends to coincide with the embedding of actors in a similar institutional framework; and can be conducive to the development of social ties. However, geographical proximity ‘per se is neither a necessary nor a sufficient conditions for learning to take place: at most, it facilitates interactive learning, most likely by strengthening the other dimensions of proximity’ (Boschma, 2005, p. 62). Other dimensions of proximity such as cognitive, social, institutional and organizational can complement, but also substitute for, geographical proximity. Interactive learning and even the transfer of tacit knowledge are made possible by organizational arrangements such as temporary work teams, collaborations or strategic alliances (Powell et al., 1996; Amin and Cohendet, 2005).

The appreciation of the importance of extra-regional knowledge is not new in the RIS approach. For instance, Camagni in a seminal paper on innovative milieu (1995) writes that ‘external energy’ for innovation processes can be captured through external networks. The RIS literature, however, has contributed to unveiling the complex and varied patterns of innovation flows. It has become apparent that the famous ‘local buzz and global pipelines’ analogy (Bathelt et al., 2004) is too simplistic. Tödtling et al. (2005) propose a typology, which builds on Storper’s (1995) distinction between traded and untraded interdependencies and Capello’s (1999) differentiation between static and dynamic aspects of knowledge transfer. Traded interdependencies typically have a formal or contractual basis stipulating the rights and responsibilities in the exchange process. Untraded interdependencies typically are informal and do not involve any immediate compensation. Traded linkages include both market transaction as well as formal cooperation, the latter allowing for a higher degree of interactive (dynamic) learning than the former. Untraded linkages encompass spillovers and informal networks. Also, informal networks involve more dynamic learning than spillovers.

It has been shown empirically that knowledge-based sectors and highly innovative firms use a variety of knowledge sources (Cooke et al., 2007; Grillitsch et al., 2013). Firms acquire knowledge from different types of source, at different geographical scales and through different types of linkages (Grillitsch and Trippl, 2014). However, the configuration and geography of knowledge networks is far from random and depends among other things on the characteristics of the RIS, on the dominant industries and knowledge bases, as well as on the configurations of value chains (Chaminade, 2011; Plum and Hassink, 2011; Tödtling et al., 2012; Martin and Moodysson, 2013). Extra-regional knowledge sources play an important role for accessing complementary knowledge, which is not available in the region, creating momentum in innovation processes, and avoiding lock-ins (Cooke, 2002; Trippl and Otto, 2009; Hassink, 2010; Tödtling et al., 2012). Hence, regional and extra-regional networks play a fundamental role in our understanding of RIS.
2.4 RIS AND THE ROLE OF POLICY

The RIS approach has essentially informed policy and has been widely used as a framework for the design and implementation of regional innovation strategies in many areas of the world. Its appeal relies on the provision of a strong basis for customized, broad-based innovation system policies.

The RIS approach has paved the way for what has become a conventional wisdom in contemporary debates, that is, the need for customization of regional innovation policies, policies that should be sensitive to the specific preconditions, potential and challenges found in the region. Such place-based innovation policies are a cornerstone of the new smart specialization approach advocated by the European Commission.

Scholarly work on system failures of RIS (Isaksen, 2001; Tödtling and Trippl, 2005) has not only offered a set of convincing arguments for justifying policy interventions beyond the traditional notion of market failure: by identifying system failures or deficiencies that are typical for various RIS types, it has also uncovered the shortcomings of ‘one size fits all’ policies. Insights into innovation problems related to ‘thinness’ prevailing in peripheral areas, system failures associated with ‘negative lock-in’ found in old industrial regions and innovation barriers resulting from ‘fragmentation’ (that is, lack of connectivity) in metropolitan areas have provided the foundation for formulating tailor-made innovation policy strategies.

The concept of differentiated knowledge bases (see Section 2.3.3) has further advanced the debate on the need for and the nature of a customization of regional innovation policies. It constitutes a theoretical cornerstone of what has become known as the ‘constructing regional advantage approach’ (Asheim et al., 2011a, 2011b). Its protagonists have shown both conceptually and empirically that analytical, synthetic and symbolic knowledge bases differ markedly in their policy needs and require specific support from RIS (Martin et al., 2011; Tödtling et al., 2013a; Martin and Trippl, 2014). This has provided a strong basis for fine-tuning innovation strategies to the knowledge bases prevailing in the region as well as the underpinning for novel policy approaches that seek to promote new development paths by stimulating novel combinations of knowledge bases and innovation modes (Asheim et al., 2011a; Isaksen and Nilsson, 2013).

Recognizing the multiple factors that influence innovation in different types of RIS, a common view has emerged favouring a broad mix of policy measures and platform policies over specific interventions favouring, for instance, a particular industry, knowledge base or mode of innovation (Cooke et al., 2007; Asheim et al., 2011a). Platform policies recognize the potential for upgrading and renewing regional economies by stimulating connections between industries and knowledge bases. The relevance of platform policies is underpinned by recent insights on combinatory knowledge dynamics (Manniche, 2012; Strambach and Klement, 2012; Grillitsch and Trippl, 2014; Tödtling and Grillitsch, 2015) as well as by ideas from evolutionary economic geography, in particular, the concept of branching based on related variety (Frenken, Van Oort, and Verburg, 2007; Boschma and Iammarino, 2009; Neffke and Henning, 2013). Accordingly, innovation, and in particular more radical and path-breaking innovations, often require the combination of different knowledge bases. Analytical knowledge alone – that is, competencies in research- and science-driven innovations – typically does not suffice. Also, empirical studies have shown that the local endowment of related industries in regions is more
conducive to growth than the presence of unrelated ones. The argument goes that the combination of knowledge from related industries produces novelty that is much more feasible than novelty generated by combining knowledge from unrelated industries. While this may hold in a stable macroeconomic context, unrelated variety may better protect regions in times of substantial structural changes as well as promote new path creation (Boschma, 2015).

Overall, the RIS approach promotes an active role for policy, which goes beyond addressing market failures and solving distributional problems. It is considered that system failures and transformative failures are legitimate reasons for policy interventions. The competitiveness of high-cost economies and the future development of transition economies cannot be grounded in comparative advantages alone but can be enhanced by turning these comparative advantages into competitive advantages and in fostering Chamberlinian monopolistic competition based on product differentiation. The RIS approach calls for an explicit policy push promoting such a high road, innovation-based, regional development strategy (Asheim et al., 2015).

2.5 RECENT LINES OF RESEARCH AND KEY RESEARCH CHALLENGES

In this section we take account of new developments within the RIS literature. We engage in particular with the latest ideas on how to forge a more dynamic perspective that can expound the nexus between regional industrial change and RIS transformation.

Recently, scholarly work has begun to explore the key factors that shape the adaption and adaptability capacities of RIS, providing fresh insights into the main determinants of regional resilience. Promising lines of research are recent conceptual analyses of the ways by which RIS structures shape industrial diversification in a variety of regional settings (Isaksen and Trippl, 2014; Trippl et al., 2015a), thereby moving beyond overly micro-focused models of evolutionary economic geography that fail to account for the role of holistic features of RIS and urging a broader, more comprehensive view on regional industrial change. This work connects the RIS approach with evolutionary theories on path dependence to explore how RIS configurations (that is, industrial structures, knowledge and support organizations, and institutional settings) influence the directions of regional change. A distinction between three main forms of regional industrial path development, that is, path extension, path renewal and new path creation, has been proposed (Tödtling and Trippl, 2013; Isaksen, 2014; Isaksen and Trippl, 2014).

Path extension occurs through incremental product and process innovations in existing firms and industries. Such intra-path changes may in the long run result in stagnation and decline due to lack of renewal. Regional industries are then locked into innovation activities that take place along existing technological trajectories constraining their potential for experimentation and space to manoeuvre into more radical forms of innovation. This can lead to an erosion of regional competitiveness and to path exhaustion. Path renewal takes place when existing firms and industries diversify into different but related activities and sectors. Such activities are facilitated by related variety (Frenken et al., 2007; Boschma and Iammarino, 2009; Neffke and Henning, 2013), combinations of knowledge bases and the integration of different innovation modes (Jensen et al.,
Path creation represents the most wide-ranging changes in a RIS. It refers to the establishment of new firms in entirely new sectors or to the introduction of products new to the market (radical innovation) (Tödtling and Trippl, 2013). Path creation is often research driven and requires active policy interventions and the creation of supportive organizational and institutional structures (Trippl et al., 2015a).

Recent research suggests that different RIS types exhibit varying capacities to induce new path development, which primarily depends on the degree of diversity in the exploration and exploitation sub-systems of a RIS (Isaksen and Trippl, 2014; Trippl et al., 2015a). It is argued that thick and diversified RIS provide favourable conditions for path renewal and new path creation due to the strong presence of related variety, different knowledge bases, knowledge generating organizations and academic entrepreneurship. However, they may exhibit weak structures for path extension brought about by a limited industrial production (exploitation) capacity. A too strong focus on and use of assets and resources for knowledge exploration and new path development can lead to a decrease in knowledge exploitation capacity, resulting in fragmentation problems. Organizationally thick and specialized RIS have rather weakly developed RIS structures for supporting new regional industrial path development. They mainly support path extension but face the risk of path exhaustion if positive lock-in turns into negative lock-in. Path renewal may also be triggered by the inflow of non-local knowledge and its combination with the highly specialized assets available within the region. Organizationally thin RIS have a limited capacity for promoting path extension and thus they have to deal with the danger of path exhaustion (although for different reasons than organizationally thick ones).

The weak capacity of many RIS to achieve path renewal and new path creation by means of endogenous resources has provoked an interest in the potential role of exogenous sources of new industrial growth paths, not least due to the increased pressure of globalization. Trippl et al. (2015b) have argued that the ways through which extra-regional knowledge (and other resources) can be exploited for, and transformed into, new path development are still poorly understood, calling for new foci of enquiry that establish greater clarification of the determinants of RIS’ capacities to attract, absorb and anchor non-local knowledge. Such research efforts would, however, require, a stronger integration of the RIS approach with established conceptual frameworks such as global production and innovation networks and the more recent literature on international labour mobility.

Research has so far sought to clarify how existing RIS architectures and configurations influence the likelihood that path creation and renewal take place and the ways policy can influence such processes. There is growing awareness that RIS themselves have to change, both as an outcome of industrial change and/or as a precondition for this change. The transformation of RIS is indeed a core issue for future research, and especially to develop a better understanding about the processes and mechanisms that drive RIS transformation. Some scholars indeed argue that the RIS literature ignores transformative dynamics at the system level (Tukker et al., 2007; Alkemade et al., 2011). Contributing to this debate, Weber and Rohracher (2012) introduce four transformational system failures. First, the RIS approach is in principle indifferent with regards to the content of innovation. However, RIS transformation and in particular transformation towards solving societal challenges requires innovation towards a certain goal.
Accordingly, the directionality failure relates to lack of strategic guidance of individual behaviour towards a shared vision. Second, innovations that contribute towards a shared vision might not be taken up by the market because a number of complementary innovations are required, user behaviour needs to be adapted or public demand is lacking. Hence, there may be demand articulation failures. Third, the policy coordination failure relates to the need to align policies and institutions from different sectors so that they provide coherent signals and incentives. The fourth transformative system failure refers to lack of reflexivity. Transformation, it is argued, requires monitoring, the involvement of actors in processes of self-governance, experimentation and system learning.

It will be an exciting challenge to better understand the transformation of RIS (and different types of RIS) and to analyse the implication for regional innovation policy. Key to achieve such an improved understanding will be a stronger focus on the micro-foundations of behaviour within a RIS represented by actors (for example, institutional entrepreneurs) and agencies. It will be interesting to assess, for instance, how new actor constellations are formed; how these actor constellations create new knowledge; how existing institutions, erected at multiple spatial scales, are recombined and reinterpreted, or new ones developed in order to create new paths; and how these processes link to strategic visions in the context of solving societal challenges. Given the inherent uncertainty related to transformative change and new path creation in regions, these processes are by nature experimental and how to approach such experimental processes is still an open question. Hence, moving towards a dynamic understanding of RIS, future research will be fundamental in understanding new path development in and the transformation of RIS.

NOTE

1. For a further development of the notion of thinness, see Trippl et al. (2015a).

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3. Understanding and learning from an evolving geography of innovation

Andrés Rodríguez-Pose and Callum Wilkie

3.1 INTRODUCTION

Cities are innovative (for example, Montgomery, 2008; Florida, 2009; Glaeser, 2011; Storper, 2013). This assertion is generally not subject to much debate (Shearmur, 2012) and is, in fact, so widely accepted that it has come to serve as the foundation of countless economic growth and development strategies the world over (for example, World Bank, 2009). More precisely, it is suggested, on the basis of a well-developed body of theoretical literature, that large urban agglomerations situated in the ‘economic cores’ of the world – the ‘mountains’ in an otherwise flattening world – host, and will continue to host, a disproportionate amount of innovative activity (Rodríguez-Pose and Crescenzi, 2008a). This has and will continue to give rise to spatial patterns of innovation characterized by a distinct ‘urban-bias’. Among the theories that predict a disproportionate concentration of innovation in cities, the most prevalent and frequently cited is that the co-location of economic actors in cities permits, even facilitates, the generation, flow and exchange of the knowledge that they rely upon to supplement their internal resources and capabilities, and ultimately to innovate (Storper and Venables, 2004, p. 352).

Empirical evidence from both the developed and developing world would seem to validate the aforementioned assertion (for example, Ó hUallacháin, 1999; Sun, 2003; Bettencourt et al., 2007; Mitra, 2007; Sedgley and Elmslie, 2011; Guimarães et al., 2013; Breau et al., 2014). There is also, however, increasing empirical evidence that suggests that a more nuanced view of the geography of innovation would be appropriate if not necessary (for example, Fitjar and Rodríguez-Pose, 2011a, 2011b; Tödtling et al., 2012; Grillitsch and Nilsson, 2015).

The aim of this chapter is to explore the subtly evolving geography of innovation from both a theoretical perspective as well as an empirical one. In doing so, it is our intention to furnish an understanding of and appreciation for the theories that underpin the study of spatial patterns of innovation. We shall draw inferences from the evolving geography of innovation that are of relevance to the formulation of new strategic approaches to the promotion of innovative activity, especially in peripheral contexts.

The chapter is organized as follows. Section 3.2 introduces and examines the various theories that predict the concentration of innovation in large, core cities, focusing specifically on the proposition that the co-location of economic actors, and the generation and flow of knowledge it permits, is not simply conducive to, but necessary for, innovation. Section 3.3 employs metropolitan patent statistics in order to explore spatial patterns of innovation in five countries: the United States, France, Germany, Japan and Mexico. Section 3.4 highlights the inferences drawn from the indicative statistical analysis performed in Section 3.3 and introduces the notion of an evolving geography of innovation.
Section 3.5 provides a theoretical interpretation and explanation for the evolving geography of innovation. Section 3.6 concludes by addressing the policy implications that arise from the observations of the preceding sections.

3.2 THE SPATIAL CONCENTRATION OF INNOVATION IN CITIES

3.2.1 Agglomeration and Innovation

According to prevailing theories of agglomeration, location and innovation, innovative capacity and innovative activity tend to concentrate in large, urban agglomerations in the ‘economic cores’ of the world (Rodríguez-Pose and Crescenzi, 2008a). This ultimately results in a geography of innovation characterized by a distinct ‘urban’ or ‘city’ bias.

Beginning with theories that address not only the location of innovative activity but also the territorial patterns of economic activity more broadly, it is frequently suggested that the abundance of suitably skilled human capital and physical capital – ‘technological’ or ‘knowledge’ infrastructure in particular – in cities will result in the emergence of innovation hubs in urban environments (Glaeser et al., 1992; Feldman, 1994; Feldman and Florida, 1994; Glaeser, 1999; Bettencourt et al., 2007; Broekel and Schlump, 2009). Cities, especially large ones, are understood, first, to be home to large concentrations of creative, well-educated individuals (Florida, 2003, 2005) and, second, to be particularly well endowed with various types of critical infrastructure, including universities and public research and development institutes (Feldman and Florida, 1994), as well as with basic infrastructure (Herman and Ausubel, 1988; Graham, 2000). This makes cities, at least from a ‘resource availability’ perspective, ideal hosts for innovative activity.

In a related vein, the economies of scale, specialization and diversification that arise from the co-location of research institutions, universities and other higher-learning institutes, and firms, among other socioeconomic actors, are also anticipated to contribute to the spatial concentration of innovation in urban areas (Jacobs, 1969; Malecki, 1979; Feldman, 1994, 1999; Feldman and Florida, 1994).

In theories that highlight the role of agglomeration, physical proximity and innovation go hand-in-hand. It is virtually commonplace to assert that the co-location of economic actors is in itself conducive to innovation (Storper and Venables, 2004, p. 352). Large cities, as dense agglomerations of co-located actors, will therefore have a decided innovative advantage and will, in turn, host disproportionate amounts of innovative activity.

Physical proximity is understood to impel innovation and promote the spatial concentration of innovative activity in urban environments for several reasons. Operation in close physical proximity to other actors permits one to ‘see’ and consequently benefit from the visible innovations of others (Lee and Rodríguez-Pose, 2013a, p. 1742). Co-location may also result in the intensification of competition between actors (Lee and Rodríguez-Pose, 2013a). This effectively serves as a catalyst for innovation as actors will feel increased pressure to innovate to either develop a knowledge-based competitive advantage or keep pace with their competitors.

The most frequently cited explanation for why physical proximity is conducive to innovation and, in turn, why innovation is anticipated to occur disproportionately in dense
urban agglomerations is, however, that the co-location of actors fosters, even facilitates, the transfer and exchange of knowledge, ideas and information (Duranton and Puga, 2001, 2004; Storper and Venables, 2004). Storper and Venables (2004, p. 352), in fact, observe that this notion of spatial proximity facilitating flows of knowledge is ‘the [one] frequently adduced to explain [the innovativeness of] cities’. Consequently, its further analysis would seem both warranted and necessary.

3.2.2 Proximity, the Exchange of Knowledge and Innovation

Prior to examining how the physical proximity engendered by co-location facilitates the exchange of knowledge, it is necessary to clarify how such a process could conceivably contribute to the innovativeness of urban actors, and the territories they occupy.

It is increasingly accepted, first, that innovation is a collective process, deeply rooted in interactions between actors of various kinds and, consequently, that access to externally generated knowledge is a primary determinant of the innovativeness of a given firm or actor (Arora et al., 2001; Gans and Stern, 2003; Caloghirou et al., 2004; Freel and Harrison, 2006; Escribano et al., 2009). That is, while an actor’s internal resources and activities – most notably, its stock of skilled human capital and its research and development activity – undoubtedly play non-negligible roles in shaping its innovativeness, its capacity to absorb, internalize and ultimately exploit externally generated knowledge is of utmost importance to its innovative capacity. In essence, firms that are exposed to and able to capitalize upon external knowledge are expected to be decidedly more innovative than those that are not.

But how does physical proximity enable processes of knowledge transfer? The value of physical or geographic proximity to the exchange of knowledge is fundamentally a product of three factors or considerations. The first of these relates to the spatial boundedness of knowledge flows; the second to the mechanism through which knowledge may be communicated; and the final one to the emergence of ‘innovation-prone’ (Rodríguez-Pose, 1999) socio-institutional contexts.

The first consideration is that knowledge – particularly ‘non-codifiable’ or ‘tacit’ knowledge (Leamer and Storper, 2001; Storper and Venables, 2004) – is ‘locationally sticky’ (Morgan, 2004). Knowledge, contrary to the oft-cited ‘world is flat’ thesis (for example, Friedman, 2005), does not diffuse costlessly, frictionlessly or limitless across space. There seems to be an empirically verifiable spatial limit to the geographic reach of knowledge flows and spillovers (for example, Varga, 2000; Acs, 2002; Moreno et al., 2005; Sonn and Storper, 2008; Rodríguez-Pose and Crescenzi, 2008b). The distance over which knowledge flows can travel is perceived to be relatively small, meaning that actors wishing to fully capture them must be located reasonably proximate to their source. Consequently, physical proximity is not only valuable but also necessary for the exchange of knowledge. The failure to be sufficiently close to other innovative actors would thus preclude one from even being exposed to knowledge flows, let alone being able to absorb and exploit them.

The second of these considerations relates directly to mechanisms through which knowledge may be efficiently communicated and how physical proximity can either help or hinder them. Two ‘types’ of knowledge – ‘codifiable’ and ‘non-codifiable’ or ‘tacit’ – can be distinguished (Leamer and Storper, 2001; Storper and Venables, 2004).
'Codifiable’ knowledge, as the name implies, is readily codifiable and in turn more easily transmitted and disseminated at a relatively minimal cost. ‘Tacit’ knowledge is ‘complex’ and does not lend itself well to expression via a conventional ‘symbol system’ (Storper and Venables, 2004, p. 354). This inhibits both its codification and interpretation rendering the communication and exchange of this type of knowledge a far greater challenge (Storper and Venables, 2004, p. 354).

So, how can ‘tacit’ knowledge, which is essential for innovation (Mascitelli, 2000) be communicated and what is the role of physical proximity in doing so? It is suggested and generally accepted that the most effective mechanism through which ‘tacit’ knowledge may be diffused is ‘face-to-face’ contact (Storper and Venables, 2004, p. 354). This ‘face-to-face’ interaction is possible only when actors are co-present or physically proximate. Co-location thus not only ensures that an individual actor is within range of spatially bound knowledge flows but also that knowledge may be more effectively disseminated or exchanged via the most appropriate mechanism, ultimately enabling its eventual internalization and practical exploitation.

The final factor concerns the emergence of an environment within which knowledge may be diffused and internalized as efficiently as possible. The co-location of actors, especially ones that share socioeconomic similarities, is said to contribute to the creation of geographically bound networks or systems characterized by high degrees of trust, collaboration, cooperation and ‘a unique set of institutional conditions’ (Fitjar and Rodríguez-Pose, 2011a, p. 557). These features arise from the constant, meaningful interactions and the familiarity permitted by operation within close physical proximity (Storper and Venables, 2004; Rodríguez-Pose and Storper, 2006). Such socio-institutional networks are, as Fitjar and Rodríguez-Pose (2011a, p. 557) note, the very bedrock of what have been termed regional systems of innovation, ‘learning regions’ (Morgan, 1997, 2004; Cooke and Morgan, 1998; Gertler et al., 2000; Bathelt, 2001) or ‘innovation-prone societies’ (Rodríguez-Pose, 1999). In these environments knowledge may be shared, exchanged and diffused efficiently, uninhibited by socially, culturally or institutionally imposed barriers.

With these three considerations and the value of externally generated knowledge to processes of innovation in mind, it is only natural that innovation mainly happens in urban environments. Large cities in particular are anticipated to be especially innovative, with the innovativeness of a city being positively related to its size (Rodríguez-Pose and Crescenzi, 2008a, p. 378). The most direct explanation for this relationship is that the very factors that grant urban environments their decided innovative advantage tend to be more abundant in larger, core cities. That is, the largest cities in economic cores generally have larger stocks of both skilled human capital and infrastructure; and are home to a greater number and a greater diversity of socioeconomic actors. The result of this abundance is: a pool of knowledge characterized by its considerable depth and breadth; dense local flows of knowledge; and the emergence of a host of knowledge-related externalities (for example, Marshall-Arrow-Romer externalities or Jacobian externalities). All of these features are not only conducive to innovation but are also thought to trigger cumulative processes whereby ever-increasing amounts of innovation will congregate in the largest urban contexts.
3.2.3 What Happens to Peripheral Areas?

Theoretical predictions concerning the innovativeness – or more accurately, the lack thereof – of peripheral contexts add a degree of nuance to the role of urban environments for innovation. While cities situated in ‘economic cores’ are assumed to be particularly innovative, their peripheral counterparts are perceived to be considerably less capable of developing and sustaining innovative activity.

‘Peripheral’ may refer to both lagging cities or regions within what might be considered a core country – regions and cities in the north of England, for example – or entire countries and the cities and regions that compose them, such as countries in central Africa. In these peripheral areas, geographic, socioeconomic, institutional or other factors are thought to be less conducive to economic, and specifically, innovative activity.

Two related factors stand out as the main obstacles for the capacity of peripheral areas to innovate.

First, from a Schumpeterian perspective, peripheral or lagging areas are less likely to have the sufficiently skilled or appropriately trained human capital nor the suitable social and political institutions that underpin ‘innovation-prone’ societies (Rodríguez-Pose, 1999). Peripheries are burdened by ‘weak economic fabrics’ that impair their capacity to develop new, original knowledge and to absorb, internalize and exploit externally generated knowledge (Rodríguez-Pose, 1999, 2001). Simply stated, peripheral contexts are less capable of generating the ideas, information or knowledge to drive innovation. This relative inability to produce new economic knowledge is compounded by a second obstacle – geographic isolation. As addressed, knowledge flows are susceptible to distance decay effects (for example, Varga, 2000; Acs, 2002; Moreno et al., 2005; Sonn and Storper, 2008; Rodríguez-Pose and Crescenzi, 2008b). Many peripheral areas are beyond the spatial limits of the knowledge flows emanating from core cities and areas and, consequently, are not sufficiently exposed to externally generated knowledge.

Peripheral areas are thus assumed to be, first, less capable of generating knowledge and, second, geographically precluded from importing and absorbing non-local knowledge. They are therefore deprived of the catalyst for innovation. This deprivation would seem to all but completely stifle innovation in peripheral contexts.

3.2.4 The Socioeconomic Implications of the Concentration of Innovation in Cities

The concentration of innovation in urban areas is not without consequence. It has, in fact, come to be associated with a variety of socioeconomic implications. The two most prominent implications relate to the economic growth of cities and their perceived capacity to impel economic growth at a broader territorial scale; and to innovation-induced inequality in cities.

Innovation is understood to be a principal determinant of economic growth and development (for example, Solow, 1957; Schmookler, 1966; Rosenberg, 1972; Romer, 1990). Cities, certainly fuelled in large part by the innovative activity they host, have experienced considerable economic success and have, generally speaking, outperformed their non-urban counterparts ( Dobbs et al., 2011). This innovation-driven economic success, coupled with macroeconomic investigations robustly linking economic performance to urbanization (for example, Chen et al., 2014), has led many to assert that cities,
as the hosts of innovative activity, are, and will increasingly be, the ‘engines’ of economic growth (for example, Quigley, 1998; Duranton, 2000; Fujita and Thisse, 2002; Glaeser, 2011). This now commonplace assertion is not, however, universally accepted (for example, Bryceson et al., 2009; Turok and McGranahan, 2013).

Economic growth and innovation in core cities also comes at a cost. It is often readily associated with interpersonal inequality that is, at least in part, related to the hosting of innovative activity. The positive link between innovation and inequality at broader (that is, regional) territorial scales is reasonably well established and understood (Lee, 2011). Only recently has attention been turned to this relationship at a more geographically refined level to explore whether the aforementioned positive relationship holds at the city level as well. More specifically, Donegan and Lowe (2008), Lee and Rodriguez-Pose (2013b) and Breau et al. (2014) probe the link between innovation and inequality in cities in the United States, Europe and Canada. In each of these three studies, innovation is found to be positively and robustly associated with inequality. These findings suggest, as Breau et al. (2014, p. 369) allude to, that the socioeconomic implications of the concentration of innovative activity in cities are not necessarily all positive and that important negative externalities are being generated.

3.3 SPATIAL PATTERNS OF INNOVATION

3.3.1 Patterns of Innovation in the Empirical Literature

When the theories painting cities as ideal environments for knowledge-intensive, innovative activity are positioned alongside those that assert that peripheral contexts are not structurally or institutionally suitable sites for innovation, the outlook for lagging areas is not good. Large, urban agglomerations in core areas, on the other hand, seem all but assured of success. But, is this always the case? Is innovation increasingly agglomerated in the urban areas of economic cores?

Fortunately, there is no shortage of empirical investigations that examine spatial patterns of innovation and highlight the concentration of innovative activity in urban environments. As a whole, these studies tend to corroborate the widespread acceptance of the notion that core cities host a disproportionately large amount of innovative activity.

The case that has received the most attention thus far is that of the United States, where numerous empirical investigations have confirmed that innovative activity is concentrated in relatively few, specifically large urban, locations. Ó hUallacháin’s (1999) comprehensive investigation into the geography of innovation in the United States revealed that an overwhelming proportion of all patents awarded to Americans were granted to residents of metropolitan areas. Moreover, he underlined that a handful of large metropolitan areas accounted for a remarkably high amount of total patenting activity. These larger metropolitan areas like New York, Los Angeles and San Francisco are not only understood to be decidedly more innovative but also to host the innovative activities associated with not one but a variety of industries (Ó hUallacháin, 2012). This propensity of innovative activity of all types to congregate in urban contexts in the United States has been affirmed by subsequent empirical investigation (for example,
Carlino et al., 2001, 2007; Lim, 2003; Bettencourt et al., 2007; Sedgley and Elmslie, 2011; Guimarães et al., 2013).

The urban bias of innovation is readily evident in the Canadian context as well. In 2006, for example, the majority of Canadians who were awarded patents by the United States Patent and Trademark Office resided in one of Canada’s 13 largest cities (Breau et al., 2014). Of these 13 cities, the most prominent were Toronto, Ottawa-Hull, Vancouver and Montreal, all of which assume prominent positions within the Canadian urban hierarchy (Wolfe, 2009). The story is largely the same across Europe (Crescenzi et al., 2007). In the United Kingdom, for example, microeconomic investigation suggests that urban firms are more innovative than their rural counterparts indicating that UK cities are in fact more innovative than non-urban environments (Lee and Rodríguez-Pose, 2013a).

This spatial concentration of innovation in cities is not uniquely a developed world occurrence. Research has unearthed a distinct urban bias in the location of innovative activity in both China and India (Crescenzi et al., 2012). In China, innovative activity is understood to be largely and increasingly concentrated in eastern regions (Sun, 2003). With specific regard for urban patterns of innovation, three cities in particular – Beijing, Shanghai and Guangzhou – account for a large share of innovative activity (Crescenzi et al., 2012, p.1057). In India, a high proportion of patenting activity is attributed to larger cities including, notably, Bangalore, Chennai, Delhi, Hyderabad, Mumbai and Pune (Mitra, 2007).

### 3.3.2 Empirical Evidence

The aforementioned empirical literature provides an adequate sense of the propensity of innovative activity to congregate in urban areas. It also, however, gives rise to other pertinent questions. Where, for example, is this tendency particularly pronounced? To what extent is the tendency towards the concentration of innovation in urban cores a ‘rule’? And, perhaps most interestingly, is there clear evidence of an ever-increasing concentration of innovation in cities? We explore these questions in the proceeding sections via an indicative examination of metropolitan patent statistics for five countries.

#### 3.3.2.1 The United States

The spatial distribution of innovation in the United States provides a particularly vivid illustration of the concentration of innovative activity in cities as well as the durability of this trend. Between 2000 and 2008, the majority of innovative output was attributable to cities, and to a small handful of large ones in particular. In 2008, 71 per cent of US patent applications originated in one of 69 cities that together only accounted for 52.7 per cent of the nation’s total population. Ten cities alone accounted for 47.6 per cent of the country’s total innovative output.

The innovative contribution of the most innovative cities during the period of analysis was significant and, as the statistics suggest, had been for some time. In fact, the proportion of total innovative output attributed to the ten most innovative cities in a given year remained relatively constant between 2000 and 2008 (Figure 3.1). In 2000, San Francisco, Boston, Los Angeles, New York, San Diego, Minneapolis, Chicago, Washington, Houston and Seattle together accounted for just 24 per cent of the total
Handbook on the geographies of innovation

population. Their collective share of innovative output however exceeded 45 per cent (Figure 3.1). Similarly, in 2008, the ten cities identified in Figure 3.2 were responsible for 47.6 per cent of American patent applications despite being home to only 23.4 per cent of the population.

Between 2000 and 2008 there was relatively little change in the national share of innovation produced by these cities (Table 3.1). Nine out of the ten cities retained a spot on the list of the ten most innovative cities throughout the period of analysis, with the lone exception being Washington. This absence of volatility suggests that the relative innovative capacities of cities and spatial patterns of innovation experience limited change in the United States over the short and medium term.

In sum, innovation in the United States is a predominantly urban process and one that has experienced limited change over time, at least in recent years (Figure 3.1). The US experience between 2000 and 2008 is very much reflective of the theories that predict the concentration of innovative activity in large, core cities.

3.3.2.2 France

The persistent innovativeness of large cities is equally if not more evident in France where, in 2008, 69 per cent of the nation’s patent applications were associated with just 15 cities. Paris alone accounted for 35.8 per cent of total innovative output.

As was the case with the United States, the proportion of total innovative output attributed to only five cities in France remained relatively stable between 2000 (54.5 per cent) and 2008 (56.3 per cent) (Figure 3.3). Marseille, Toulouse, Grenoble, Lyon and – towering above all – Paris were France’s main innovation hubs and accounted for over half

Source: Authors’ elaboration, OECD statistics: Metropolitan Database.

Figure 3.1 PCT patent applications by the United States, 2000–08
Understanding and learning from an evolving geography of innovation

of France’s total innovative output in 2008 (Figure 3.4). The proportion of France’s patent applications attributed to these five cities in 2008 (56.3 per cent) was so large that it actually exceeded the share of US total patent applications attributed to its ten most innovative cities (47.63 per cent). The only country of those considered in the analysis
Handbook on the geographies of innovation

Figure 3.3  PCT patent applications by France, 2000–08

Source: Authors’ elaboration, OECD statistics: Metropolitan Database.

Figure 3.4  PCT patent applications by the five most innovative cities in France, 2008

Source: Authors’ elaboration, OECD statistics: Metropolitan Database.
that displayed a more marked geographic concentration of innovation activity by the end of the period of analysis was Japan.

Again, the French geography of innovation confirms the predictions of prevailing theories of location, agglomeration and innovation. France's core cities were decidedly more innovative and limited change – if anything, these five cities marginally increased their share of innovation in France – was witnessed.

3.3.2.3 Germany

The German case provides a weaker exemplification of the propensity of innovation to concentrate in cities. In 2008, Germany’s five most innovative cities accounted for 27.98 per cent of the nation’s total patent applications (Figure 3.6). Close to 50 per cent of the total was associated with one of 24 cities. While this proportion is less than the share of national innovative output attributed to the most innovative cities in the United States, France, Japan and Mexico, it is still indicative of an urban-biased geography of innovation.

The share of innovative output associated with the most innovative cities held reasonably constant between 2000 (30.8 per cent) and 2008 (27.98 per cent). It did decrease over the period of analysis (Figure 3.5), however, not to the same extent as in Japan and Mexico and it actually increased between 2004 and 2005, and 2006 and 2007, respectively.

Interestingly, and unlike any of the other countries considered, none of the cities were decidedly more innovative than any of the others – Stuttgart (7.2 per cent in 2008) and Munich (8.11 per cent) accounted for comparable proportions of national innovative output that were not substantially larger than those attributed to Berlin (4.52 per cent), Frankfurt (4.27 per cent) or Mannheim (3.87 per cent) (Figure 3.6). This would seem to
suggest that while innovation in Germany is indeed an urban process, it is more evenly spread across several cities than in the other countries examined in this chapter.

3.3.2.4 Japan
The innovative prevalence of cities was particularly pronounced in Japan. Innovative activity was more geographically concentrated in the five most innovative cities in Japan by the end of the period of analysis than in any of the other countries considered in this section – 36 cities produced 73 per cent of the nation's patent applications in 2008. Two cities alone – Tokyo and Osaka – were responsible for over half of the nation's patent applications during that same year. However, in contrast to the United States and France, the spatial geography of innovation appears to be changing, and rapidly so.

While innovative activity remained concentrated in a handful of large Japanese cities (Figure 3.7), the proportion of national innovative activity that occurred in the nation's five most innovative cities decreased between 2000 and 2008. In 2000, the five most innovative cities in Japan accounted for close to 65 per cent of the total Japanese innovative output. By 2008, this figure had fallen to 58.6 per cent suggesting that while cities like Tokyo, Osaka, Nagoya, Fukuoka and Sapporo (Figure 3.8) remained critically important hubs in the Japanese innovation system, innovative activity was becoming increasingly spatially dispersed. Tokyo's experience exemplifies this trend. In 2000, Tokyo alone was responsible for over 38 per cent of the country’s innovative output. By the end of the relatively short period of analysis, this share had fallen to 34.3 per cent.

While innovation in Japan generally conformed to the prevalent view of the concentration of innovation in urban cores, trends during the period of analysis imply that a

Source: Authors’ elaboration, OECD statistics: Metropolitan Database.

Figure 3.6 PCT patent applications by the five most innovative cities in Germany, 2008
Understanding and learning from an evolving geography of innovation

Figure 3.7  PCT patent applications by Japan, 2000–08

Source: Authors’ elaboration, OECD statistics: Metropolitan Database.

Figure 3.8  PCT patent applications by the five most innovative cities in Japan, 2008

Source: Authors’ elaboration, OECD statistics: Metropolitan Database.
subtle, but critically important shift is occurring: innovative activity has become more geographically dispersed, with increasing amounts of innovation occurring outside the ‘usual suspects’.

### 3.3.2.5 Mexico

The Mexican case is perhaps the most interesting of the five cases covered. As was the case in the United States, France, Germany and Japan, innovative activity was highly concentrated in a small handful of larger cities throughout the period of analysis. It was not, however, anywhere near as spatially concentrated in 2008 as it was just nine years prior to that (Figure 3.9).

In 2000, Mexico’s five most innovative cities accounted for just over 65 per cent of the country’s total innovative output. Nine years later, this share had fallen to just over 40 per cent. In 2008, Mexico City, Monterrey, Guadalajara, Puebla and Hermosillo were responsible for 42.9 per cent of total patent applications (Figure 3.10). Such a figure is still indicative of a marked territorial concentration of innovation that is of a similar magnitude to that of both France and Japan. It also, however, represents a significant decrease in the share of innovative output produced by the country’s top cities and suggests that innovation is, contrary to theoretical prediction, becoming more dispersed across the country (Figure 3.9) (see also Rodríguez-Pose and Villarreal Peralta, 2015).

Like Japan, the spatial pattern of innovation in Mexico was, in one respect, reflective of the dominant theoretical predictions, yet wholly inconsistent with them in another. During the period of analysis, innovative output was highly concentrated in Mexico’s large urban agglomerations. The nine years between 2000 and 2008, however,
saw a substantial dispersion of innovation that is not entirely explicable by the theories introduced in the previous section.

3.4 TOWARDS THE EMERGENCE OF A NEW GEOGRAPHY OF INNOVATION?

The five cases presented in the previous section give us a glimpse of what is likely to be a much more complex geography of innovation than the one that can be inferred from a simple interpretation of the dominant theories. In many ways the picture that emerges is certainly one of geographic concentration. In radically different contexts in both developed and developing countries, innovation has a reasonably strong propensity to concentrate in large, core urban areas, and a small number of them at that. There is, however, some variation in the extent to which the largest and most innovative cities dominate the panorama of innovation. The shares of national innovative output, for example, attributed to the five most innovative cities in France (56.3 per cent in 2008) and Japan (58.6 per cent) dwarfed that of Germany’s five most innovative cities (27.98 per cent). They even exceeded the proportion of total American patent applications associated with its ten most innovative cities (47.6 per cent). Nevertheless, the cases considered confirm that innovation is a predominantly urban phenomenon. Hence, co-location and the centrality of the transfer and exchange of knowledge to the innovativeness of economic actors is seemingly vindicated by empirical evidence.

The evidence presented, however, does not unequivocally support the idea of an
ever-growing concentration of innovative activity in core cities. In the cases of the United States and France, there was no decline in the geographic concentration of innovative activity. Japan and Mexico, however, provide evidence of a certain level of deconcentration. As illustrated by Figures 3.7 and 3.9, respectively, both Japan and Mexico experienced not insignificant decreases in the share of innovative output produced by their most innovative cities. Such decreases suggest a change in the urban-biased spatial patterns of innovation. There are thus some signs that, in at least some parts of the world, innovative activity, while by no means evenly distributed across space, is becoming increasingly geographically dispersed and may no longer be confined to core cities.

Such evidence stands in stark contrast to the dominating views about the geography of innovation in two related respects. First, where innovative activity is anticipated to become increasingly concentrated in a limited number of core urban locations, the cases of Japan and Mexico suggest that the opposite may be true at least in some contexts. More and more innovation is seemingly occurring outside a small number of core cities. Second, theories predicting the spatial concentration of innovation in cities on the basis of the existence of externalities arising from agglomeration imply that processes of concentration should, in effect, be self-reinforcing. This in turn implies that such spatial patterns of innovation will persist indefinitely. The Mexican and Japanese experiences would suggest otherwise, namely, that urban-biased patterns of innovation are, in fact, not indelible.

Another closely related challenge to prevailing theories is raised by an emerging body of literature documenting innovation in what are generally considered peripheral environments. Prevailing theories posit that innovative activity will concentrate primarily in urban environments, specifically in the ‘economic core’ rather than in peripheral areas. There is mounting evidence, however, that suggests that this theoretical assertion may not hold universally true.

This is, for example, the case of both Norway and Sweden. These two countries, in spite of their geographic peripherality relative to the European core, have managed to develop and sustain considerable innovative dynamism and in doing so have defied theoretically founded expectations (for example, Andersson et al., 2005; Fitjar and Rodríguez-Pose, 2011a, 2011b; Rodríguez-Pose and Fitjar, 2013; Grillitsch and Nilsson, 2015). Norway in particular exhibits a number of traits that are consistent with widely accepted definitions of peripherality beyond its physical distance from the core (Rodríguez-Pose and Fitjar, 2013). These include the absence of the large urban centres and, relatedly, an urban system composed of a handful of small cities with relatively few firms. Consequently, the potential for the emergence of agglomeration-related knowledge externalities in Norway is limited (Rodríguez-Pose and Fitjar, 2013).

While these are only two countries and extrapolation must be done with appropriate degrees of caution, their experiences are perhaps indicative of a more pervasive trend – other research has suggested that innovative activity can and is occurring beyond the core regions of, for example, Canada (Doloreux, 2003; Doloreux and Dionne, 2008) and Austria (Tödtling et al., 2012). More importantly, their experiences, like Japan’s and Mexico’s decreasing spatial concentration of innovation, point towards an evolving geography of innovation. More precisely, it seems that peripheral areas – cities, regions and countries alike – that were once assumed to be less capable of developing and sustaining
innovative activity are, in some cases, making increasing and substantive contributions to the overall innovative activity of the global areas within which they are situated.

Like the anticipated spatial concentration of innovative activity in core, urban environments, this evolving geography of innovation is not without socioeconomic implications. For the peripheral territories that have developed and managed to sustain innovative capacity, it may be inferred from the established link between innovation and economic growth (for example, Solow, 1957; Schmookler, 1966; Rosenberg, 1972; Romer, 1990) that those regions are now better positioned in the pursuit of competitiveness, economic growth and dynamism. For the environments that have not yet managed to develop an innovative capacity of their own and have struggled to cope with a more knowledge-intensive economy, the evidence that innovation can occur in _ex ante_ less favourable environments is cause for cautious optimism. It suggests that peripheral cities and regions may, perhaps with some strategic intervention, eventually become innovative, begin to reverse their economic fortunes and ultimately compete in an increasingly competitive globalizing economy.

### 3.5 UNDERSTANDING THE EMERGING GEOGRAPHY OF INNOVATION AND THE INNOVATIVENESS OF PERIPHERAL ENVIRONMENTS

The evolving geography of innovation is not readily, or at least completely, explicable by the prevailing theories of location, agglomeration or innovation. This raises some difficult but profoundly important questions. More precisely, if operation within close physical proximity to other economic actors, and the sharing and exchange of knowledge it permits, are effectively prerequisites for innovation, why and how is it the case that non-negligible amounts and, in some cases, increasing proportions of innovative activity are occurring outside core urban environments?

On the one hand, the centrality of externally generated knowledge and interaction with other economic actors to processes of innovation remains a fundamental pillar of innovation. On the other, recent evidence points to the emerging role of the exposure to and the capacity to absorb external knowledge, often generated at considerable geographical distances, in order to complement internal activities and resources for the generation of new knowledge and greater innovative capacity. It also remains true that most peripheral contexts are less able to generate new economic knowledge. Hence, in order to generate innovation and, especially, to compete with the dynamic innovative cores, actors operating outside the confines of large urban agglomerations must be capable of accessing and capitalizing upon non-local knowledge. Peripherality remains an important burden to innovation (Section 3.2.3): geographic isolation and lack of local critical mass restricts and sometimes precludes access to, as well as the capacity to absorb, critically important spatially bound knowledge flows and spillovers (Varga, 2000; Rodríguez-Pose, 2001; Acs, 2002; Moreno et al., 2005; Rodríguez-Pose and Crescenzi, 2008b; Sonn and Storper, 2008). Finding a way to tap into the knowledge that is ‘stuck’ in core cities and regions becomes essential to guarantee innovation in peripheries. This indicates that the processes of collective learning, innovative collaboration and the exchange and transfer of knowledge that were once assumed to be facilitated by and dependent upon physical proximity...
can and in fact do occur in the absence of close physical proximity. The pertinent question that remains now is how?

The most appropriate response to this question is derived from Boschma’s (2005) seminal contribution on proximity, which is itself informed by the work of the French School of Proximity (for example, Bellet et al., 1993; Kirat and Lung, 1999; Gilly and Torre, 2000; Rallet, 2003; Torre and Rallet, 2005). The primary thrust of Boschma’s argument is that physical proximity is but one of a number of different ‘proximities’ and that ‘[it] per se is neither a necessary nor a sufficient condition for learning to take place: at most, it facilitates interactive learning, most likely by strengthening the other dimensions of proximity’ (Boschma, 2005, p.62). That is, in his view, other types of proximity – cognitive, organizational, social and institutional, all of which can exist at a distance – are as, if not more, fundamental to processes of knowledge sharing and transfer. Physical proximity, while perhaps conducive to the development of the other ‘dimensions’ of proximity, cannot compensate for a lack of them. It is therefore complementary and its absence may be compensated for by developments in other proximities. Boschma’s argument implies that if a geographically isolated economic actor is sufficiently cognitively, organizationally, socially and/or institutionally proximate to economic actors located specifically in innovative agglomerations in core areas, they can participate in interactive processes central to innovation, even at a distance.

Consequently, if a peripheral firm or actor is capable of developing a productive relationship with innovative actors located abroad on the basis of shared cognitive, organizational, social or institutional traits rather than on the basis of a shared geography, the burdens of peripherality may be alleviated. Distant actors may be able to interact, learn and exchange knowledge in a way that is at least comparable to co-located actors. Forging and maintaining such a productive relationship is understood to require substantial commitment – financial and otherwise – on behalf of all of the parties involved (Bathelt et al., 2004). Nevertheless, purpose-built connections, now commonly referred to as ‘pipelines’ (Bathelt et al., 2004), may, at least in part, explain the innovativeness of peripheral actors and the areas they occupy, as well as the catch-up in innovative capacity that is being witnessed in some peripheral areas.

The function and critical importance of extra-local connectivity to the innovative capacity and dynamism of regions and the actors that occupy them is well understood. Bathelt et al. (2004, p.42) assert that pipelines enable ‘the integration of multiple selection environments that open different potentialities and feed local interpretation and usage of knowledge hitherto residing elsewhere’. Stated more simply, the formulation of pipelines permits the inflow of non-local knowledge and ideas, thereby increasing both the depth and breadth of the local knowledge pool upon which actors rely, ultimately preventing intellectual stagnation and opening previously unforeseen opportunities for innovation. It is generally accepted, however, that pipelines assume a supplementary role. That is, pipelines are presumed to be complements to local knowledge, interactions and ‘buzz’ (Camagni, 1995; Maillat, 1998; Crevoisier, 2004; Bathelt et al., 2004). Implicit in this assumption is that the development of pipelines cannot compensate for a lack of local knowledge or innovative capacity and therefore cannot be the sole explanation for the innovation occurring in geographically isolated environments.

A small but growing number of recent investigations have sought to explore whether the establishment of these external ‘pipelines’ can facilitate innovation in peripheral
contexts and, in turn, provide a viable explanation for new trends in the spatial pattern of innovation. Interestingly, empirical evidence from the European periphery suggests that forging relationships with non-local partners can have a profound effect on the innovativeness of firms in peripheral areas.

Fitjar and Rodríguez-Pose (2011b), for example, consider a sample of 1604 firms from Norway’s five largest city-regions – Oslo, Bergen, Stavanger, Trondheim and Kristiansand – and find evidence of a positive relationship between the international connectivity of a firm and its innovativeness. That is, the establishment of international partnerships and connections has had a considerable positive effect on a firm’s capacity to develop radical product, incremental product and process innovations (Fitjar and Rodríguez-Pose, 2011b, p. 1264). Furthermore, firms that relied solely on domestic linkages and interactions were found to be less likely to be innovative (Fitjar and Rodríguez-Pose, 2011b, p. 1264). This effectively reinforces the notion that peripheral contexts lack the density of innovative actors to generate meaningful local knowledge flows and externalities. International connections are thus of paramount importance, especially for peripheral areas. This is further corroborated by Fitjar and Rodríguez-Pose’s (2011a) more detailed examination of firms in southwestern Norway. Once again, a firm’s likelihood of introducing innovation is greater when that firm has ‘strong cooperative relationships with relevant global production networks within their industries’ (Fitjar and Rodríguez-Pose, 2011a, p. 570). The results of both of these studies are complemented by those of Tödtling et al. (2012), who suggest that Austrian information and communications technology (ICT) firms located in a country’s periphery tend to draw on non-local knowledge sources more than their counterparts in the core. More recently, Grillitsch and Nilsson (2015) sought to specifically interrogate whether explicit collaboration amongst actors is used and can compensate for the absence of local knowledge flows and spillovers via an empirical examination of Swedish firms. Their results suggest that firms operating in peripheral environments do in fact turn to the formulation of relationships with other actors, both domestically (that is, with core firms) and abroad, in an effort to compensate for their peripherality and restricted access to local knowledge spillovers and flows (Grillitsch and Nilsson, 2015).

Taken together, the results of these empirical studies suggest that the establishment of purpose-built, non-local connections can compensate for the lack of local knowledge generation and circulation and in turn facilitate processes of innovation in once innovation-averse contexts. In that respect, knowledge ‘pipelines’ help explain not only the innovation occurring in the periphery but also the catch-up that has become evident in recent years in some parts of the world.

3.6 CONCLUSIONS: IMPLICATIONS FOR INNOVATION POLICY AND ECONOMIC DEVELOPMENT IN THE PERIPHERY

Recent evidence of an evolving geography of innovation and the variety of trends described above give rise to profound policy implications, especially for peripheral areas. Theoretical predictions concerning the innovativeness of core urban agglomerations coupled with a robust body of evidence validating them have produced a long infatuation
with ‘cluster-based’ or ‘agglomeration-based’ growth policies that still persists today. The perception that the co-location of innovative actors in close physical proximity to one another is broadly conducive to the free flow and exchange of knowledge has given way to strategic approaches that encourage the agglomeration of economic actors in the hope that such processes can be reproduced across variable contexts to impel innovation and economic growth.

More precisely, Rodríguez-Pose and Fitjar (2013, p.360) assert that ‘the logic behind the formation of clusters was no different from what was happening in cities’. That is, it was assumed that promoting agglomeration would give rise to processes and outcomes most readily associated with cities. These include: (1) the emergence of economies of scale and externalities from which small and medium-sized enterprises (SMEs) in particular could benefit; as well as (2) the constant interaction between socioeconomic actors and the formation of networks that facilitate processes of collective learning and collaboration, the diffusion of knowledge and the development of local buzz (Rodríguez-Pose and Fitjar, 2013, p.360).

Cluster-based policies have emerged across Europe and beyond in the most and least economically developed countries and regions alike (Freser, 2005; Davies, 2006; Borrás and Tsagidis, 2008; Oxford Research, 2008; Yusuf et al., 2008; Zeng, 2008) even though, as Ketels (2013a, p.249) notes, the jury still seems to be out on whether they are both warranted or effective. Such policies have not been universally successful. Ketels (2013b, p.276), for example, observes that ‘assessments of the impact of cluster programmes come again to very heterogeneous results’. With specific regard for intermediate and peripheral environments, Rodriguez-Pose and Fitjar (2013, p.360) highlight that there is evidence of both successful clusters as well as cluster-based intervention that ‘had either limited or no effect’ in such contexts, citing empirical research from Latin America (Giuliani et al., 2005) and Europe (Rodríguez-Pose and Comptour, 2012). The constrained success of cluster-based policies is undoubtedly attributable to any number of context-specific conditions or challenges. That said, a commonly cited barrier to their success relates to one of the defining features of economic peripheries. More specifically, peripheral contexts are characterized by an insufficient density of innovative actors and a generally weak economic fabric that together effectively preclude the emergence of the knowledge-related synergies and externalities that actors in the core rely upon and benefit from. Simply put, the economic fabrics and underlying socioeconomic conditions in peripheral contexts are such that even the aggressive promotion of co-location and agglomeration is insufficient to produce the knowledge flows necessary to spur innovation. The importance of contextual conditions to the viability and success of a cluster is made particularly evident by Rodriguez-Pose and Comptour’s (2012) analysis of clusters in Europe. The authors conclude, as would be theoretically anticipated, that ‘having a favourable socioeconomic setting’ is of paramount importance to the innovativeness and growth of a cluster (Rodríguez-Pose and Comptour, 2012, p.227).

The failure of many of these cluster-based policies should be, in itself, sufficient cause for their timely reconsideration and revisitation. That said, the recent evidence of, and plausible explanations for, innovation occurring in what were assumed to be innovation-averse peripheral contexts provides even more reason for a re-evaluation of prevailing policies and the proposal of more appropriate ones.

Recent empirical investigations into processes of innovation and innovative firms in
peripheral contexts, while admittedly limited in number, point in the direction of innovative firms in the European periphery compensating for a lack of locally generated knowledge flows – the most prominent innovation-related burden of peripherality – by forging productive relationships with non-local innovative actors to encourage the inflow of external knowledge. Nowhere is this more evident than in Sweden where Grillitsch and Nilsson (2015) find that innovative firms in the periphery forge more external relationships and collaborate more with other firms than their counterparts in core regions. This finding suggests that while firms in core regions can, and in fact do, rely on local knowledge flows and spillovers – as would reasonably be expected – innovative peripheral firms are forced to, and find success in, actively seeking out partners and establishing productive, collaborative relationships to compensate for a lack of locally generated knowledge.

Extra-local relationships built not on geographic proximity but on cognitive, organizational, social and cultural similarities are robust enough that processes once assumed to only be possible in close geographic proximity are actually possible over much greater distances. It would seem then that fostering the establishment of such ‘pipelines’ and encouraging the development of extra-local connectivity would be a particularly viable strategic approach to encouraging innovative activity and in turn economic growth and dynamism outside economic cores. Such an approach would constitute a much-needed alternative, if not at least a complement, to cluster-based development approaches.

Pipeline approaches have a number of advantages. The effectiveness of cluster-based policies outside core environments is simply contingent on far too many factors, many of which relate to slow-to-change structural socioeconomic and institutional conditions. This implies that achieving measurable success is not only a daunting task, but also that meaningful change and development is much less likely in the shorter term. These so-called ‘pipelines policies’, on the other hand, work within the confines imposed by peripherality and a weaker socioeconomic fabric and seek to inject peripheral economies and the actors that occupy them with externally generated knowledge to supplement their respective internal resources and activities via the creation of extra-local channels. The establishment of such channels, unlike more profound structural reforms and changes, is conceivably achieved in the shorter term, meaning that the tangible results of pipeline policies may reasonably be expected relatively immediately.

Contextual conditions cannot be neglected in the pursuit of pipeline policies as the characteristics of specifically local actors, and the territory more broadly, shape the extent to which they can absorb and in turn benefit from the creation of pipelines and externally generated knowledge (Cohen and Levinthal, 1990; Fitjar and Rodriguez-Pose, 2011a, 2011b; Grillitsch and Nilsson, 2015). The promotion of pipelines is then not sufficient in and of itself to impel innovation. Rather, policies to encourage the establishment of purpose-built connections should be included within broader innovation strategies and should be supplemented by initiatives that will assist local actors to, first, capitalize upon the imported knowledge and second, begin to develop indigenous knowledge generation capacity to decrease the reliance on non-local sources of knowledge.

Overall, the geography of innovation is evolving. The evolutions thus far have been relatively subtle and may not yet be completely geographically ubiquitous. But these evolutions represent a signal that perhaps our theoretical tools cannot adequately explain the mechanisms through which many peripheral areas across the world are increasingly defying centripetal tendencies and remaining stubbornly innovative in the face of...
enormous difficulties. Further analysis of how innovation occurs in these areas will allow us to complement and perhaps even challenge the prevailing view that changes in innovative activity inevitably lead to a geography of innovation dominated by a limited number of world hubs.

NOTES

1. Internal activities shape the ‘absorptive capacity’ of an actor and exercise influence on their ability to benefit from external knowledge flows (Cohen and Levinthal, 1990).
2. Sections 3.3.2.1 to 3.3.2.5 employ data from the Organisation for Economic Co-operation and Development’s (OECD) ‘Metropolitan Database’. The use of this dataset permits the city-level analysis necessary to achieve the aims of this chapter and explore our research questions. Statistics are, unfortunately, only available for the years between 2000 and 2008.
3. See Carrincazeaux et al. (2008) for a review of the contributions of the French School of Proximity.

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Understanding and learning from an evolving geography of innovation


4. The cultural embeddedness of regional innovation: a Bourdieuian perspective

Ben Spigel

4.1 INTRODUCTION

Innovation is a culturally embedded process. Far from the socially sterile view of the linear innovation model in which scientific discoveries made in a university or corporate labs are pushed out to a waiting marketplace, the innovation process is enmeshed in a multitude of overlapping cultural, social and economic contexts. But while there is general agreement in the literature that culture – be it the culture of a place, an organization, an industry or a people – matters in the innovation process, there is less consensus about how culture matters (Gertler, 1995; Cooke, 2001; Baronet and Riverin, 2010). Culture is often viewed as a monolithic force deterministically influencing the innovation process rather than as a context surrounding innovation practices of individual actors. As a result, current understandings of the innovation process often have no way of explaining deviation from established cultural norms or how new practices and methods develop. This is particularly true of the Regional Innovation Systems (RIS) literature, which emphasizes the importance of local cultures in explaining innovation outcomes but has struggled to describe the exact role these cultures play.

The purpose of this chapter is to offer a sympathetic critique of how culture is used in RIS and other innovation literatures. RIS frameworks use culture as a way to partially explain the uneven geography of innovation and why this unevenness persists in the face of continued public interventions and investments. However, without a more nuanced view of the role of culture, these accounts risk falling into cultural determinism, basically asserting that a region’s culture causes innovation to occur (or not occur), and thereby robbing actors of their individual agency. A more multiplex view of culture is required, a view where culture is a context in which different innovation practices materialize, influencing which practices make sense in a given situation rather than causing them to occur. Importantly, this view should acknowledge the role of multiple forms of culture, not just the culture of a place but also that of the organization, the industry or the value chain in which the innovation is occurring.

In order to address these issues, this chapter draws on the work of Pierre Bourdieu, in particular his conceptualization of practice as emerging from the intersection of fields – historically produced norms and power relations – and habitus, actors’ internalized dispositions and understandings of those fields. A Bourdieuian approach avoids many of the common pitfalls associated with existing uses of culture, in particular, the lack of a process connecting cultural structure with everyday practice and the difficulty of incorporating the role of multiple cultural influences (Spigel, 2013). The following section discusses how the role of culture has been used to explore the uneven geography of innovation, particularly within the RIS literature. While the importance of culture
The cultural embeddedness of regional innovation is well understood, less progress has been made in understanding the processes linking culture with action, and there persists the problem of how to theorize the role of overlapping cultural values in the innovation process. To overcome these issues, Section 4.3 introduces the work of Pierre Bourdieu and discusses how it can be used to study the innovation process. The remainder of the chapter explores how a Bourdieuan approach can account for the many overlapping cultural influences affecting actors within a RIS and how it can provide a more detailed and nuanced perspective about the role of culture within the innovation process.

4.2 CULTURES OF INNOVATION AND INNOVATIVE CULTURES

The RIS literature emerged out of a dissatisfaction with existing National Systems of Innovation models that neglected the substantial internal variation of innovative activity within nations (Cooke, 1998; Oinas and Malecki, 2002). Regions, rather than nations, are a particularly important scale to study the innovation process due to the localized nature of knowledge spillovers between co-located firms and universities through processes of interaction and observation (Henry and Pinch, 2000). RIS refer to the actors, policies, institutions and networks that develop within regions supporting the innovation process (Asheim et al., 2011). Strong RIS create environments that encourage innovation within firms by helping facilitate knowledge spillovers between them and other knowledge producers like universities, as well as by facilitating public policies that foster radical knowledge generation and innovation (Cooke et al., 1998). Beyond this, RIS help to explain the ‘stickiness’ of new innovations: they create a cultural and technical environment that allows for easier communication of complex tacit knowledge between local innovators (Guillaume and Doloreux, 2011).

Cultural outlooks are a crucial part of RIS. They encourage or discourage innovative activities such as collaboration between firms, knowledge spillover through informal networking and labour mobility, and risk taking (Thomas, 2000). Comparative work such as Saxenian (1994), James (2005) and Aoyama (2009) have illustrated how cultural structures develop in regions and over time and contribute to substantial differences in innovation practices that cannot be explained through corporate strategy or local resources alone. Understanding the role of culture in RIS is crucial for two reasons. First, it acts as an institutional foundation upon which other parts of the RIS, such as networks, policies and firms, rest. Cultural outlooks create a context in which these more material structures develop (Depner and Bathelt, 2005). Second, cultural outlooks are much harder to influence than other factors in an ecosystem such as public policies or the investment environment. Policymakers often have to deal with the existing cultural environment ‘as is’ when trying to create or sustain RIS. This makes understanding how cultures affect the innovation process critical in designing new support policies and programmes.

Culture can be conceptualized as a type of institution: a historically produced and durable ‘accepted, existing pattern of interaction’ (Bathelt and Glückler, 2014, p. 341). That is, culture can be viewed as a set of norms, outlooks and beliefs that influence the types of activities seen as acceptable and commonplace in a given situation. Within regions, these cultures develop over time, most often through the spread of the
organizational culture of a dominant local employer (such as an international firm or a leading university) across the region through spinoffs and movement of workers from the major anchor organization to other firms (Aldrich and Fiol, 1994; Schoenberger, 1997). The consequences of this are most visibly shown in Saxenian’s (1994) *Regional Advantage*, which illustrates how the open culture of universities like Stanford and firms like Hewlett Packard diffused into Silicon Valley’s broader culture, in contrast to the more closed-off corporate culture of Boston’s Digital Equipment Corporation and its wider technology community. The ability of firms to cooperate and share market and technical knowledge influenced how each region reacted to shifts in the global technology economy in the 1980s, with Silicon Valley able to take advantage of the burgeoning personal computer market while firms in Boston were not able to turn their innovative abilities towards new markets.

But while the literature is clear that culture matters, there is less consensus about how cultural outlooks influence the innovation process. There are two dominant theoretical frameworks for connecting cultural beliefs with the innovation process: embeddedness and proximity. Embeddedness refers to the ways in which economic activities are enabled and constrained by their relationships with social systems and actors’ personal connections (Granovetter, 1985; Zukin and DiMaggio, 1990). While Granovetter’s theory of embeddedness has become one of the most popular concepts in the social sciences, it provides precious little guidance on the processes through which cultural embeddedness influences economic activities such as innovation (Hess, 2004). It lacks a clearly established process to link contexts with actors’ individual actions. Granovetter’s main argument is that economic activities are embedded in social contexts, but this says little about the ways in which these contexts influence action. James (2007, p. 395) contends that embeddedness is ‘under-specified’ as a concept and does not fully explain the processes that link culture and action. Similarly, much of the embeddedness literature in geography ignores wider arrays of institutional factors that go beyond the local scale and lacks a relational conception (Jones, 2008; Bathelt and Glücker, 2011). Actors do not adjust their practices to conform to their social contexts just because they fear sanction, nor do they limit themselves to employing practices that have been sanctioned within the cultural context they are embedded in. Rather, actors develop their practices within a particular social context but still possess the ability to experiment with new actions that they think may be sensible given their goals, resources and situation.

Within the innovation systems literature, the concept of proximity has emerged as an alternative way of understanding the role of culture in the innovation process. Building on arguments made within the embeddedness literature, culture is seen as a source of ‘proximity’ that allows for easier cooperation and communication between different groups (Boschma, 2005; Capello and Faggian, 2005). People and organizations with ‘close’ cultural outlooks will have an easier time communicating complex tacit knowledge than those with more distant cultural views, in the same way that geographically proximate organizations are understood to collaborate more effectively than those that are more geographically distant (Gertler, 2003; Torre and Rallet, 2005). While this cultural proximity can be engendered by long-term geographic proximity between actors, satellite offices of an international organization are more likely to share a common culture with each other than they are with nearby firms that come from a different organizational context.
However, cultural proximity is a very narrow and restricted view of one of the most complex social forces in the human experience. Cultural proximity is often modelled as a binary variable that proxies belonging to the same organization or industry. Similarly, shared geography is often seen as evidence of shared culture. This misses a great deal of cultural heterogeneity within groups and ignores other sources of shared cultural understanding that can build up over time. More importantly, proximity frameworks offer very little insight into the relationships between cultural outlooks and innovative practices: they can only suggest why inter-firm communication is easier or harder, which itself is a small part of the overall innovation process. Other aspects of the innovation process, such as why firms and people might proactively engage with others to acquire new knowledge or take the risks associated with radical innovation, are left unanswered.

One outcome of these weaknesses of existing cultural approaches is the inability to explain the effect of separate but overlapping cultures. Actors are not the product of a single culture: they are influenced by ethnic or religious cultures linked to their upbringing, the organizational culture of their employer, the cultural outlooks embedded in their industry, and the culture of the region they live and work in, to name just a few potential influences. Some of these cultural outlooks might agree upon what types of innovation practice are considered normal or acceptable, but others might conflict. Neither embeddedness nor proximity frameworks fully explain the effects of this complex overlapping of cultural influences. However, questions of overlapping cultures are crucial in understanding the interactive innovation and learning process, especially as open innovation approaches continue to dominate the research and development (R&D) strategies of both large and small firms (Gassmann et al., 2010).

Such issues are particularly acute within the RIS literature. Firms in a RIS are often assumed to share a collective local culture by virtue of their shared geography (Baronet and Riverin, 2010). Firms and actors must adapt to this culture if they are to successfully integrate into the region’s collaborative networks. Culture heterogeneity is frequently ignored, with one factor such as ethnicity or location often used as the sole indicator of shared cultural norms and beliefs (Hsu and Saxenian, 2000; Raghuram and Strange, 2001). However, our lived experience tells us this is not the case. Firms in different industries within the same region might have different orientations towards collaboration and risk due to their organizational culture or industrial norms (for example, banking versus technology). Similarly, we would also expect to see cultural differences between startups and more established firms, especially if those startups spun out from larger companies in response to management conflicts (Klepper, 2010). Cultural conflicts between university and industry researchers are often observed despite their close physical proximity in research parks (D’Este and Patel, 2007). Cultural differences can lead to conflict within RIS that act as barriers to innovation. However, at the same time these differences can introduce a heterogeneity of practice that can help drive radical innovations and new solutions.

The innovation systems literature has done comparatively little to integrate more complex views of culture into its theoretical frameworks or empirical investigations. Culture is often treated as a single dummy variable for the sake of methodological parsimony and there has been limited investigation into the complex relationships between actors with differing cultural backgrounds or outlooks. This obscures the complex dynamics that occur when actors cut across multiple cultures, such as a local culture...
tied to the place where they live, the organizational culture tied to their workplace and the sectorial culture tied to the industry they are a part of (the two latter having no necessary geographic dimension). This is more than an inconsequential detail: few if any actors involved in the highly socialized innovation process exist in a single cultural context detached from all other influences. Existing approaches to culture neglect these other cultural influences and provide little guidance as to how we should understand their interaction. As a result, there is a need for a more nuanced approach to culture that embraces its heterogeneous and overlapping nature and that can explain how its complex structure influences innovation strategies and practices in a way that goes beyond a simple supportive/non-supportive cultural binary.

4.3 BOURDIEUAN ALTERNATIVES TO REGIONAL CULTURE

4.3.1 Bourdieu’s Sociology of Practice

Given these issues, there is a need for an alternative explanation that can account for the role of multiple cultures in the innovation process. The work of Pierre Bourdieu is a particularly useful framework to explore these issues. Bourdieu developed a sociology of practice that examined the origins of the everyday actions people employ in pursuit of their goals (Bourdieu, 1977, 1990). These practices emerge from the intersection of the rules of the social systems those actors inhabit with the actors’ internalized understanding of how those rules apply to them (Bourdieu and Wacquant, 1992). Innovative actors employ practices they believe make sense given their goals and knowledge of their social context. Social structures like culture do not determine what practices can be performed, nor do they cause actions to occur, but instead create an environment in which actors can employ a near infinite, but non-random, variety of practices in pursuit of their goals.

From this perspective, innovation can be conceptualized as a bundle of practices that encompass how individuals develop knowledge within organizations, absorb outside knowledge through both developing formal partnerships and informal social networks, and how they recombine this knowledge to develop new market insights and technologies. These practices take place in fields, ordered systems of social relations and power hierarchies (Bourdieu, 1977). Fields represent a practical sense of what practices are both sensible and possible. Bourdieu (1990) frequently compared fields to the rules of games such as football: it has both formal rules (the length of a match) and informal rules (what is seen as poor sportsmanship). Within these rules players can employ a near infinite array of practices in pursuit of their (literal) goals.

Actors’ practices are oriented around capital, which Bourdieu (1986) defined broadly as any type of labour appropriated on an individual basis. This includes traditional economic capital (income or profits), social capital (resources in a social network), cultural capital (knowledge of social rules) and symbolic capital (regard for certain professions or social positions). The values of these capitals are not fixed: their values depend on the structure of the field they are acquired and used within. While the main goal of a firm may be to increase its economic capital through increased sales or efficiency brought about by innovation, individual actors may engage in these innovative practices for quite
different reasons. For instance, they may wish to enhance their social capital through networking with others in order to increase their future career prospects, or they might want the symbolic capital of being associated with the development of a world leading technology or product, both of which increase their standing in the community. Depending on the nature of the fields an actor operates within, the symbolic capital of working with a ‘cool’ startup on a cutting-edge technology might be more valuable than the economic capital of getting higher pay at a larger firm (Neff, 2012).

The rules and social hierarchies of a field are understood through an individual’s habitus: their internalized knowledge of and disposition towards the fields they operate within (Swartz, 1997). An actor develops an implicit understanding of the rules of a field through their habitus, allowing them to decide what types of practices are likely to be successful given their goals and position within the field. An individual’s habitus reflects his or her position within a field, so that ‘tastes and dispositions structure the individual’s subjective actions and experience’ (Hallett, 2003, p. 130). This leads to different forms of practices appearing sensible to actors with different habitus. While a field may have objective rules, these rules are not understood in the same way by actors with different dispositions and backgrounds, leading to divergent practices and goals.

To date, there has been little integration of Bourdieu’s sociology of practice into the innovation literature. With a few exceptions, such as Geels (2004), innovation scholars have largely drawn on Bourdieu’s work on social capital rather than his broader work on practice. However, there has been significant interest in Bourdieu by organizational (Battilana, 2006; Emirbayer and Johnson, 2008; Swartz, 2008) and entrepreneurship scholars (de Clercq and Voronov, 2009a; Karataş-Özkan, 2011; Pret et al., in press). Much of this research has investigated how norms of legitimacy are developed within fields: actors who are seen as legitimate are more able to gather and employ the resources they need to accomplish their goals (de Clercq and Voronov, 2009b; de Clercq and Hoing, 2011). Within this framework, culture can be understood as the stabilized patterns of practice that develop through actors’ habitus-based understanding of the fields they operate within (Spigel, 2013). Culture represents the dominant understandings of a field within a particular group or region and the types of practices normalized within it. In particular, culture captures the stabilized understandings of the rules of a field within actors’ habitus. While actors can and do violate the rules of a field, these violations go against the ‘sensibilities’ of the culture and therefore reduce violators’ legitimacy in the eyes of others, making it harder for them to acquire the resources they need to start and grow the firm. Culture can therefore be described as a process through which actors develop a practical understanding of what types of practices make sense given their knowledge of a field and their habitus-informed goals.

4.3.2 Fields of Innovation

Actors involved in the innovation process – technologists, managers, researchers and customers, to name a few – are embedded in multiple overlapping fields and have different habitus through which they understand the often conflicting rules and structures of these fields (Fligstein, 2001). These fields and habitus will affect the innovation practices actors employ inside and outside their jobs. Innovative actors are affected by several different fields, such as:
The organizational field: the norms and goals of the firm or organization they work for, including reward structures, corporate missions and organizational culture.

Sectorial field: the norms and power relations in the market or technology sector (for example, telecommunications or consumer software), including career expectations, job mobility and paths to market and firm exit.

The local field: norms and outlooks associated with the community in which the actor lives and works, such as attitudes to work and family, risk taking and entrepreneurship.

Ethnic/national/personal fields: beliefs about risk, reward and career goals developed within the structure of an actor’s personal heritage and background, such as their ethnic culture, religious upbringing or educational experience.

Each field has its own set of norms that affect the values of different forms of capital within them and that normalize different types of practices and outlooks, contributing to the development of different types of innovative practices. For example, a researcher in a university and a technologist in an international firm may both inhabit the same local field whose structure seemingly encourages deep networking and knowledge sharing, such as a place like Silicon Valley or Boston. But their position within their different organizational fields will influence their relationships towards innovative practices such as networking. The university researcher might avoid networking with other local researchers because she believes it will do little to advance her pursuit of the capital she is most concerned with: the symbolic capital of high ranking publications based on original research. The technologist might see the value of open communication but not believe that networking will contribute to the form of capital he is most concerned about: his department’s profit margin and the promotion tied to it. Thus, even in a local field whose structure seems to encourage open communication and knowledge sharing, actors may choose contradictory practices due to the influence of other fields. The practices an actor employs will depend on how they interpret the conflicting norms of the fields affecting them and the types of capital they are most interested in accumulating based on their habitus-informed understanding of these fields. These choices are not dictated by a single field but emerge organically from an actor's understanding of their position within multiple fields.

Innovation practices emerge from an actor's habitus-based understanding of how they fit into the overlapping array of fields they work within. This is usually a non-conscious process where actors employ the practices that make sense to them given their own personal goals (which are developed within the context of these overlapping fields) and what types of practices are seen as legitimate, common or sensible given their current context. Actors can, of course, make strategic decisions to improve their own position within the field by developing calculated new practices and approaches. But even this decision is made within the context of their position within multiple fields: while changing jobs to move up a corporate hierarchy might be normalized in a sectorial field it may be seen as illegitimate and disloyal in a local field that has been historically dominated by a single major employer. In order to balance the often competing demands of these fields, an actor must be ‘a virtuoso [who can] play on all the resources inherent in the ambiguities and uncertainties of behaviour and situation in order to produce the actions appropriate to each case’ (Bourdieu, 1977, p. 8). Practices are not dictated by the structure or ‘culture’
of a field; rather their interactions create contexts where certain types of practices seem to be better suited for given situations.

From this perspective it becomes clear that a single point of similarity such as being in the same region is not enough to assume that actors have similar attitudes towards innovation practices. The influence of other organizational, sectorial or personal fields will temper the effects of the local field. Rather, actors develop their practices within the context of multiple, overlapping and often conflicting fields. However, at the same time it is necessary to acknowledge the importance of the local field. Actors are embedded in this field as part of their everyday life; unlike their organizational or sectorial field they do not leave the local field when they leave work at night. The local field is likely to have the strongest impact on innovation practices for actors deeply embedded in it.

The organizational fields of firms that develop within the region will be heavily influenced by the structures and rules of the local field as will the habitus of actors who are raised and educated in it. This is because the organizations' founders will have developed their habitus in the local field, affecting their practices and outlooks as they develop a corporate culture. Indeed, entire sectorial fields can be shaped by the local field in which they originally developed, as evidenced by the continued cultural connections between the computer technology sector and Silicon Valley's culture. However, at the same time, the local field can be influenced by the organizational culture of dominant employers or the ethnic/national fields of dominant populations: an example is how Detroit's local field developed in conjunction with the organizational field of firms like Ford and General Motors (Klepper, 2007).

The local field can be thought of as a ‘lens’ through which actors understand other organizational and sectorial fields. While actors are influenced by all types of fields, they must meet the rules of the local fields if they are to be seen as legitimate actors on a day-to-day basis with others who are influenced by the local field. As illustrated in Figure 4.1, the local field acts as a ‘lens’ through which actors understand other fields and develop their practices. While non-local fields have their own unique rules and norms, how these rules are implemented is heavily influenced by the structures of the

![Figure 4.1 Relationships between local and non-local fields](image)

Richard Shearmu, Christophe Carrincazeaux and David Doloreux - 9781784710767
Downloaded from Elgar Online at 08/06/2018 07:11:37AM via Hungarian Academy of Sciences
local field due to the fact that the actor is constantly embedded in the local field and their habitus has developed around it. This is particularly true of those who grew up and were educated in that field, but even newcomers must adapt – at least to some extent – to the structure of the local field. However, the precise influence of the local field vis-à-vis other fields depends on the actors’ position within them: an innovator who does not plan on remaining long in a region (for instance, an executive who expects to be quickly transferred out to another role) will not need to adjust their practices to meet the exceptions of a local field as much as someone who expects to spend their life in that region.

For instance, many entrepreneurs form their entrepreneurial identity by interpreting an idealized vision of Silicon Valley through their own local characteristics (Gill and Larson, 2014). This idealized view of Silicon Valley entrepreneurship can be seen as the structures and norms of the field of technology entrepreneurship. This field is interpreted through the lens of an actor’s locally developed habitus and translated into practices. Because actors’ habitus are developed within their local field, their responses to the rules and structures of non-local fields are coloured by the practices that make sense locally.

James's (2005, 2007) study of technology innovation in Salt Lake City is an instructive example of this process. Many technology firms in the region are either founded or dominated by Mormon workers, whose religion discourages many practices commonly associated with the technology industry, such as working late and copious consumption of caffeine and alcohol. These Mormon workers must find a balance between the norms and customs of the local field (and the personal field of their religion) and the broader field of the technology, whose structure often conflicts with this local field. Similarly, when outside firms open offices in the region to tap its skilled labour force or when non-Mormon workers join firms whose organizational field is dominated by Mormon norms, managers must find a way to balance the competing norms of their organizational field with the local one. However, at the same time Mormon workers deeply embedded in the local field will have to adjust their own practices if they work for an outside firm whose organizational field normalizes practices like drinking after work or late nights at the office. Successful actors in this situation will be able to improvise new practices to achieve their goals based on their habitus-based understandings of the multiple fields they experience, such as substituting networking in bars for networking at church events in order to achieve the same knowledge flow found in other regions. Actors without a good habitus-based understanding of the local field (such as newcomers to the region) might encounter difficulties if they try to employ the same innovation practices that worked in a place like Silicon Valley or Denver. They will have to experiment with new practices that make sense both within their pre-existing organizational field as well as the new local field.

From this perspective the local field (or any field) does not determine innovation practices. Instead, practices are created through actors’ habitus-based understanding of the fields they operate within. The local field plays a role in how the rules of other fields are understood in proportion to its importance in actors’ day-to-day lives: the importance of the local field will vary based on how embedded an actor is in it and on the power of that field. Actors who are new to the local field or who are only temporarily inside it (for example, a manager transferred in from another location) will not be heavily influenced by it. This may lead to conflict if their practices violate local norms as their habitus is not attuned to the unwritten rules and expectations of the local field. However, if they
The cultural embeddedness of regional innovation

continue to engage with the local field they will eventually learn its contours and their habitus will adjust accordingly.

4.4 CONCLUSION: FIELDS, CULTURES AND REGIONAL INNOVATION SYSTEMS

Regional innovation systems depend on a coherent local culture that encourages the knowledge sharing and cooperation that underlie successful innovation. However, this local culture cannot be thought of as homogeneous: different organizational or sectorial structures might clash with the local culture that has developed over time. This can lead to conflicts between actors within these different organizational structures about their engagement with their local RIS. This cultural conflict should not be seen as simply an attribute of underperforming RIS; every RIS will have a diverse array of cultural influences affecting different actors and firms. However, current models of culture within economic geography and innovation studies have difficulty explaining how these cultural conflicts influence the innovative activities of actors. Regional culture is too often cast as a deterministic force that causes innovation to occur and a resource that firms can access simply by locating an office within a region. Most importantly, it is difficult to conceptualize how actors develop their innovative practices within the context of multiple, overlapping cultural influences. As a result, the role of culture within the RIS literature is underdeveloped. There has been little discussion about the relationship between local cultural systems and the organizational cultures of firms and industrial cultures of different sectors. However, these potential interactions must be conceptualized and understood in order to develop effective ecosystem policies that can build on the complex structures of local cultural outlooks.

A Bourdieuan perspective provides a nuanced approach to this complex situation and a conceptual vocabulary to apprehend it. The activities underlying regional innovation systems can be understood as discreet practices carried out by actors as part of their day-to-day lives. Actors choose practices not because cultural or organizational rules dictate them but because carrying out those practices makes sense given their habitus-based understanding of the multiple fields they are embedded within. This allows for more individual agency within innovation systems, with actors developing new practices and strategies based on their individual circumstances. However, this is not to ignore the methodological challenges of a Bourdieuan approach. Its practice-based approach makes it difficult to use standard measures of innovation such as patents or R&D investments, instead requiring qualitative methods that seek to identify the discreet practices underlying innovative activities and the rationales behind them. But, as shown in the burgeoning Bourdieuan entrepreneurship literature, this work has the potential to help integrate a practice and process-based perspective into innovation studies.

NOTE

1. Bourdieu’s work focuses specifically at individual rather than organizational practices. Organizational practices, such as innovation strategies, are the outcome of individual practices and decisions that are made within the context of an organizational field.
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5. Proximity dynamics and the geography of innovation: diminishing returns or renewal?

Marie Ferru and Alain Rallet

5.1 INTRODUCTION

Discussions about the role proximity plays in the organization of economic activities first started 25 years ago. We know what happened next (Benko, 1998): in the early 1990s, a small research group composed of French economists, some from the field of industrial economics and others from regional economics, undertook to analyse the connections between the geography of activities and their industrial dynamics based on the notion of proximity. This is a concept with many meanings, but with its roots firmly planted not only in geography but also in economics and socioeconomics. Indeed, the interesting feature of this concept was that it was impossible to reduce proximity to its geographic dimension because it had so many other acceptations.

Thus, the concept of ‘proximity’ was able to condense the group’s ‘epistemological program,’ which consisted in analysing the relationship between territory and industry, not as a relationship of expression (space as a geographic projection of industrial organization or, conversely, as an incarnation of geographic determinism), but as a dialectical relationship where the two terms are co-determined simultaneously. Proximity was seen as a conceptual tool to analyse this relationship as, across its many meanings, it revealed the need to connect space and economy together, something that had always proved difficult. The originality of the group’s work was therefore not the use of the word itself, but using it with this divided meaning and making this division the departure point for their studies, as until then the notion of proximity had been understood only in terms of its geographic dimension.

Two questions were then posed, corresponding to two possible approaches to the space/industry relationship using the multi-faceted proximity concept. First, how does geographic proximity explain the territorialization of economic activities, given that other forms of proximity can account for this geography? And second, to what extent can territory, understood as a node of proximity relationships, generate specific industrial dynamics? Although these two questions were not limited to the problem of innovation, studies soon focused on it, owing, on the one hand, to public policy issues (what is the rationality behind cluster policies and what is their scope?), and, on the other hand, to the fact that innovation activities, more than any others, were presumed to require a strong geographic proximity.

The group quickly extended its scope to cover more disciplines, as the interconnection of proximities was also of interest to sociologists, geographers and town planners. In addition, questions other than innovation were often covered (the city, conflicts and so on). National and then international conferences were organized every two years and the impetus was maintained. Since the inaugural issue of the Revue d’Économie Régionale et
Proximity dynamics and the geography of innovation

Urbaine in 1993, special issues of French journals have also been produced on the topic (Economie Rurale (2004, no. 280), Revue d'Economie Régionale et Urbaine (2008, no. 3), Nature, Sciences, Sociétés (2009, vol. 17, no. 4) and also international journals such as International Journal of Sustainable Development (2004, vol. 7), Regional Studies (2008, vol. 42, issue 6, 2015; vol. 49, issue 6, 2015)). As a result of numerous seminars and workshops, many papers have been published.1 Journals have accepted an ever-growing number of contributions (see above) and many doctoral theses have been written on these subjects since the mid 1990s, clear evidence of the interest shown by young researchers in an approach to socioeconomic geography based on notions of proximity. Lastly, institutional initiatives have been introduced bringing research laboratories together to develop applied studies on the geography of innovation, to deal with measurement issues and produce localized data (for example, the Eurolio network).2

Overall, there was a fairly steady growth in research on this subject until the beginning of the 2000s, then everything exploded: the concept of proximity was popularized and internationalized, bringing it into mainstream economics and leading to a proliferation across the board of studies on proximity. The idea spread that the concept of proximity could be applied to all subjects, that its different forms could be found and assessed in a range of economic or social fields.

However, the question of the geography of activities, and of innovation in particular, still remained one of the main issues in the work raised by the French School of Proximity. Many authors, such as Boschma (2005), Torre (2006), Ponds et al. (2007), Lorentzen (2007), Carrincazeaux et al. (2008), Massard and Mehier (2009) and Ferru (2010), have attempted to explain the link between proximity and innovation by considering innovation activity as the resultant of various types of proximity. Many applied studies have been and continue to be produced.

How do we situate all these studies 25 years later? Our aim here is not to propose a new survey of studies on proximity and innovation. There are already some excellent ones, to which we make reference (Bouba-Olga et al., 2008; Carrincazeaux et al., 2008). Our aim is rather to examine the trajectory of these studies, the stage they have reached in their life cycle: rise, maturity or decline? Is there saturation or renewal? Burnout or resilience?

This chapter therefore provides a critical review of proximist literature on the geography of innovation from the point of view of its future prospects. We shall answer the following questions: (1) How have studies evolved? (2) In what direction are they developing today? (3) What are the best avenues for renewal, that is, how to escape diminishing returns? In fact, despite the significant contribution made by the work of the ‘proximists’ in analysing the geography of innovation, we are currently witnessing an upsurge in empirical studies and an accumulation of results where value added is not always evident. This is a widespread phenomenon, applicable to any research group: creativity tends to fade over time. This is why it is useful to look at the stage in its life cycle that a research trend – such as this one on proximity and innovation – has reached.

We first put forward a periodization of studies on proximity based on the publications it has produced (Section 5.2). Next, we consider the specific content of the two periods that we define (Sections 5.3 and 5.4). We then suggest some avenues for renewal that may lead to a ‘rebound cycle’ (Section 5.5). Section 5.6 concludes.
5.2 STAGES IN THE DEVELOPMENT OF STUDIES ON PROXIMITY AND INNOVATION

We have identified publications combining the key words ‘proximity and innovation’ since the beginning of the 1990s. Articles were selected by applying three different filters:

- direct contributions (words present in the title)
- total audience of the trend (words present in the body of the text)
- intermediate level (words present in the abstract).

There were few direct contributions and their numbers remained relatively stable over the period studied. For the other categories there was a marked dynamic with two major breaks defining three main periods (shown in Figure 5.1).

The first period is the founding period (1990–2005) marked by the predominance of works by the French researchers who were involved in starting the trend. It begins with the special issue of the *Revue d’Economie Régionale et Urbaine* (1993), bringing together contributions from the core group of founding members. In this first period, we also find theoretical discussions that aimed to set out an analytical framework (see Pecqueur and Zimmermann, 2004) as well as a first set of empirical studies (see the review by Dupuy and Burmeister, 2003), and attempts to link the subject to the debate on public territorial innovation policies. Biannual conferences were held, the first organized in Toulouse in 1995, and these provided a framework for the dissemination of the proximity approach. It was in this way that the audience for this trend began to grow. These conferences

![Figure 5.1](https://example.com/figure51.png)

*Note: N = number of papers in economics, business, geography and urban sciences from 1990 to 2015.*

*Source:* Econlit and business source complete.
fairly quickly became the ideal place for discussions between researchers from different disciplines and of different nationalities.

This first period seems to mainly comprise contributions from a group of French researchers working around the founding members of the School of Proximity. Confrontations between theoretical development and field research are in evidence. Some authors focused on the very definition of proximity and suggested refining the analytical categories (Gilly and Torre, 2000; Pecqueur and Zimmermann, 2004; see below) while, at the same time, case studies were being carried out (Belis-Bergouignan, 1997; Carrincazeaux et al., 1998; Rallet and Torre, 2001, among others). Thus, the work of the founders developed, and indeed occupied a recognized place in the academic landscape of regional science at the beginning of the 2000s, but their influence remained for the most part national.

The second period was marked by much more in-depth analysis, many more empirical studies and the internationalization of research. The publication in 2005 of a special issue of the journal *Regional Studies* marked a turning point as it set out some analytical propositions that opened the way to broader empirical studies to test these propositions and widen their audience in academic circles. The article by Rallet and Torre (2005) defines the notion of proximity based on the interrelationships between spatial and non-spatial proximities, taking into account information and communications technologies as a support for coordination and economic actors’ capacity for ubiquity, showing the importance of temporary geographic proximity and making the distinction between proximity and localization. A second article, by Boschma (2005), defines and operationalizes the analysis by distinguishing five categories of proximity. These analytical clarifications paved the way for empirical studies on databases in France (Autant-Bernard et al., 2007) and elsewhere (especially the Netherlands, see below).

After 2010, we observe a slowdown in the number of publications, leaving open the question of whether we are now entering a third period. This is marked more by legitimate methodological concerns than by intellectual creativity, though there are frequent reminders that wide-ranging theoretical debates are needed. There are most notably two important points, outlined in two special issues on proximity: first, the desire to improve the tools used to measure proximity, and second, the desire to internationalize the approach. The predominance of empirical studies and their internationalization are very much linked with the growing interest among public innovation policies for ‘clusters.’ Are these policies well founded? Is it right to use public funding to support cluster-based policies? Are they ‘effective’? To determine this, we need to understand how the innovation actors (firms, research centers and so on) organize innovation processes in spatial terms in the different sectors. Many empirical results have been accumulated, and although the debate continues, authors tended to converge upon the limited role of geographic proximity in coordinating innovation activities, which was basically what the founders sought to show.

Thus, we can say that the program of the School of Proximity has largely been achieved. But this raises the question of revitalizing our subject matter as we cannot be satisfied with endlessly repeating the same studies, especially as the results tend to converge. This is why we are calling for a renewal in this subject area. Some contributors have already achieved this by broadening the proximity approach to objects outside the innovation field (for example, explaining conflicts, coordinating non-innovative activities.
and so on). Renewal can also be considered as the incorporation of new questions, which may or may not be in the field of innovation.

5.3 ISSUES AND FOUNDING PRINCIPLES OF PROXIMITY STUDIES

For a better understanding of the trajectory of studies on proximity, let us go back to the beginning. With the growth of regional science studies on industrial districts and innovative environments, ‘proximity group’ authors opposed what they considered to be a ‘localized presupposition’ (Gilly and Torre, 2000, p.26). An analytical framework was produced, showing that there was a multiplicity of forms of proximity, which supported their claims. Indeed, it enabled authors to deduce the territory from the analysis as a set of interrelated proximities, instead of assuming it a priori. They could then provide renewed public policy recommendations.

5.3.1 The Starting Point . . .

A group of French researchers, mainly economists, sociologists and geographers, found that research on industrial districts and innovative milieus at the beginning of the 1990s was too territory-biased. They joined together to strengthen the scientific basis of their work, at a time when studies by the GREMI appeared to predominate in regional economics. The group's main aim was to use an analysis based on spatial and non-spatial proximities, which would lead to alternative public policy recommendations by highlighting the localized presuppositions of the innovative milieu approach. A secondary aim was to provide institutional legitimacy for young researchers (unrecognized until now because of their heterodoxy) from different scientific institutions (see Carrincazeaux et al., 2008 for more information on these scientific and institutional origins).

A special issue (no. 3) of the *Revue d’Economie Régionale et Urbaine* in 1993 marked the group's official birth. It was the first result of their collective thinking, setting out the terms of what ‘proximity economics’ could be, and proposing a new framework in the field of regional science, which at that time appeared ‘in crisis’ (Bailly and Coffey, 1994). More generally, the proximity group was born from the theoretical aim to endogenize territory within industrial dynamics by closely associating the latter's spatial and productive determinants and by combining regional economics and industrial economics, which until then had been by and large distinct (Rallet and Torre, 1995). Research into industrial districts and innovative milieus opened up interesting perspectives but raised two issues. First, when they exist, territories are considered as having intrinsic virtues and thus are studied through their positive effects. Second, this approach leads to overestimation of the effect of local interactions relative to non-local ones, and makes clusters a near-exclusive model of local development. In the proximity approach, the territory is considered the result of coordination between agents. It is built by socioeconomic interactions, which may be local or non-local. The objective is to study the local/non-local interaction mix that explains the geography of economic activities.

On this basis, the researchers proposed some original guidelines and presented a program of research with strong connections to public policies. The key question was
to determine ‘to what extent innovation processes involve or do not involve a proximity relationship between the participating agents, given that there are two options: to territorialize or not to territorialize the relationship?’ (Rallet, 1993, p. 370). From the outset, therefore, territorialized innovation policies were the main target for research, that is, the regional and local dimension of technological policies.

5.3.2 In Search of an Analytical Framework

In line with the work by Perroux (1955), all the authors working on proximities agreed that alongside physical proximity, which ‘deals with separation in space and links in terms of distance,’ there was also a non-physical proximity that deals with ‘economic separation in space and links in terms of the organization of production’ (Gilly and Torre, 2000, pp. 12–13). They agree that ‘being in proximity with someone does not only mean being near him/her, it might also mean having a strong complicity with a person who is geographically distant, whether that person belongs to the same circle of friends, family or even the same network of firms or professionals’ (Rallet and Torre, 2004, p. 25). There is a general consensus on the notion of geographic proximity, even though using notions of geographic proximity, physical proximity or spatial proximity are open to discussion. Physical proximity is relative in two ways (Rallet and Torre, 2005), depending first on means of transport (transportation time and costs), and second on people’s judgment of the distance. In order to operationalize this notion, Rallet (2000, p. 39) clarifies it by saying that ‘agents are geographically close if they are able to meet on a daily basis.’

Initially, highlighting non-spatial proximities (alongside spatial proximity) was mainly for methodological purposes. Rather than putting forward a theory, the more modest aim was to produce an analytical framework around the proximity concept in order to assess economic spaces in a new way. But researchers then tried to enrich the proximity concept by theoretical references, sometimes leading them to break down proximity differently. Thus, a recurring theoretical debate took place between those supporting institutionalist approaches (Gilly and Lung, 2008; Talbot, 2008), who distinguished between institutional proximity and organizational proximity, and supporters of more interactionist approaches (Pecqueur and Zimmermann, 2004; Rallet and Torre, 2005), who broke down organized proximity into a rationale of similarity and of belonging. These distinctions reflect the different conceptual theories adopted by the authors (Torre, 2008). More recently, theoretical additions have been made to the initial proximist typologies (see the 2008 special issue of the Revue d’Economie Régionale et Urbaine). Talbot (2008), belonging to the institutionalist trend, incorporates contributions by former institutionalists while Bouba-Olga and Grossetti (2008), generally considered as interactionists, propose a new typology of proximity that is essentially non-spatial and which they describe as socioeconomic proximity. Based mainly on studies of social embedding (see above), these latter authors show the presence, together with physical proximity, of socioeconomic proximity, revealing the importance of the embeddedness of actors into their social and economic environment. Within this socioeconomic proximity, they distinguish proximity of resources from proximity of coordination. The question remains as to which proximity(ies) will be important for innovation, since operationalization of the different proximist typologies was fairly limited in the group’s early period.

Alongside this theoretical debate, consideration is also given to the proximist typology
from a more operational perspective. Some authors stress the ambiguity and the risks of overlap between different types of proximity. In particular, Boschma (2005) stresses ‘the particularly vast notions of organizational and institutional proximities’ (Boschma, 2004, p. 21). He considers that ‘for analytical reasons, it is essential to clarify and define the different dimensions of proximity in such a way that overlap is avoided as much as possible, and research can assess the effects of each dimension’ (Boschma, 2005, p. 62) and proposes to remove such limitations, ‘thanks to a fivefold classification of geographical, cognitive, social, institutional and organizational proximity.’ Cognitive proximity corresponds to the degree of convergence/overlap between the basic knowledge of two firms. Given the tacit, idiosyncratic and cumulative nature of knowledge, the greater the cognitive proximity, the stronger the capacity for absorption of external knowledge and the possibility of innovation (Nooteboom, 2000). Organizational proximity must be distinguished from the preceding one and is defined as ‘the extent to which relations are shared in an organizational arrangement, either within or between organizations’ (Boschma, 2005, p. 65). Coordination is facilitated and transaction costs reduced when knowledge is exchanged. Based on the literature on embedding (Polanyi, 1944; Granovetter, 1985), social proximity refers to the social embedding of actors, to the existence of inter-individual social relations. Lastly, according to North (1990), institutional proximity indicates the macro-economic environment in which the firm is embedded. It corresponds to the rules of the game, the culture and values that actors share. These last two forms of proximity are a source of confidence that fosters knowledge exchange.

This analytical breakdown of proximity is described as evolutionist. According to the author, proximity categories are chosen and defined in such a way as to ensure that there is no overlap between them. By distinguishing the five forms of proximity analytically, it is then possible to introduce cognitive and social proximities while clarifying the other dimensions.

Despite the criticism leveled against this typology (see Bouba-Olga et al., 2014) and against those that preceded it, it did enable the proximist typology to become operational, it popularized approaches in terms of proximity and it widened the audience. Thus, at the end of the 2000s, based on Boschma’s typology (2005), many authors sought to evaluate the respective weight of the five categories of proximity in innovation processes. According to Google Scholar, the article was cited over 2348 times since 2005, providing the author with a sizeable ‘citation capital’ (Insel, 2009).

In line with the positions of the proximist trend founders, Boschma (2005) claimed that geographical proximity is neither a necessary nor a sufficient condition for learning and innovation. In this and later articles (Boschma and Frenken, 2010) he adopted a critical stance on the general acceptance of the economic virtues of geographic proximity: too little and too much proximity may both harm performance (Boschma, 2005; Broekel and Meder, 2008). He developed the notion of a ‘proximity paradox’ (Boschma and Frenken, 2010) where the ‘weak’ version consists in showing that a high level of proximity is advantageous for bringing partners together without affecting performance, and the ‘strong’ version maintains that too much proximity can have a negative effect on company performance in terms of innovation. In the same way that Nooteboom (2000) indicated for proximity/cognitive distance, Boschma and Frenken (2010) suggested the existence of an optimal level for the different forms of proximity. The different versions of the proximity paradox seem to be verified empirically. To illustrate this, Cassi and
Plunket’s results (2014) on patents in the genome sector show that while different forms of proximity encourage the formation of new collaborations, an increase in the degree of technological proximity reduces performance in terms of innovation, suggesting that there is an optimal level of proximity. Broekel and Boschma (2012) also demonstrate, in the aeronautics sector in the Netherlands, the positive influence of forms of proximity on the formation of a network, but they also show that too strong a cognitive proximity leads to inferior performance.

5.4 LATER STUDIES TAKE TWO DIRECTIONS: EMBEDDEDNESS AND NETWORK MODELING

During this second period, many advances were made in combining proximity and innovation. In this section, we focus on two major trends and two important contributions to the direction taken by research into proximity that affected its life cycle.

On the one hand, studies aimed to deepen the social foundations of the proximist typology for the geography of innovation. In this respect, incorporating the embeddedness theory seemed to be productive and confirmed the idea that not everything can be explained by economics. On the other hand, research enhanced the analysis with a purely economic explanation and continued the search for operationalization and quantification of forms of proximity by network analysis.

5.4.1 Social Embeddedness

By distinguishing between the various forms of proximity, different cases/situations could be categorized according to the overlapping of spatial and non-spatial proximities. This distinction also allows the authors to test the hypothesis that non-spatial proximities could explain the geographic proximity observed during the innovation process. Indeed, some authors show that the functional reasons (that is, the need for face-to-face interactions and tacit knowledge exchange) that are supposed to explain the co-localization of economic agents involved in the same innovation process are not necessarily valid. Co-localization – and more generally the territorialization of the innovation process – could be explained by external mechanisms, such as social embedding. In other words, territorialized innovation-related collaborations could be explained at least in part by the existence of local-based interpersonal relations. Indeed, one route that we believe should be highlighted and which has helped move forward the analysis of coordinating actors and their relationship with territory is that of social embeddedness. Michel Grossetti, a sociologist and founding member of the proximity group, stressed the importance of this notion from the beginning of the 2000s (that is, social embeddedness could explain the geographic concentration of actors participating in innovation projects) and guided some of the proximity group’s research in this direction.

The notion of embeddedness has its origins in studies inspired directly by the new economic sociology. As we know, in a famous article published in 1985, Mark Granovetter defended the theory that economic activities are dependent on the interpersonal relations in which the actors are involved, and described this dependence as embeddedness. This theory has several implications. First, economic activity is dependent on more general
social structures, which are not social groups or categories but networks (Wellman and Berkowitz, 1988). Second, the relevant level of economic action is not that of firms or organizations in general, but that of individual actors and their relations.

Exchanges between firms and academic research laboratories, and innovation relations generally, have also been studied from the embeddedness theory standpoint. For example, Walter W. Powell, who worked in the biotechnology industry in California (Powell and Brantley, 1992), sought to show that ‘behind the formal links there are informal relations that give them life, support them, and frame their development’ (Powell and Smith-Doerr, 1994, p. 384). The notion of embeddedness has also been applied in the context of the debate on the effects of spatial proximity. For many researchers localized effects (already demonstrated particularly by Acs and Audretsch, 1988; Jaffe, 1989; Audretsch and Feldman, 1994, and many others) observed in innovation activities can be explained less by simple physical proximity and more by the growing importance of social networks in economic activity and the fact that for the most part these are local. Most existing studies show that social relations are more easily formed in the local neighborhood, ‘the greater the distance, the less contact and support’ (Mok et al., 2007, p. 434). Empirical studies such as Wellman (1996) on a sample of Toronto inhabitants, Fischer (1982) on the population of San Francisco and Grossetti (2007) on Toulouse confirm that personal networks make up a significant share of local relations. This is also the case in studies inspired directly by the new economic sociology, like the article cited above by Powell and Brantley, or which refer to it explicitly, like that by Saxenian (1994), or by Ferrary and Granovetter (2009) on Silicon Valley. Michel Grossetti shows that few studies are available to verify that embedding collaboration in social networks can promote the construction of local partnerships.

Combining the notions of embeddedness and proximity, Michel Grossetti and Marie-Pierre Bès (2001, 2002) have sought to fill this gap. Using a mixed method called quantified narratives, the authors assess the weight of the effects of embeddedness and spatial proximity in creating collaborations for innovation; they carry out numerous surveys on French research scientists, asking about their research relations with industrialists. In a more recent survey of start-ups, Grossetti et al. (2008) show the variable effect of different types of proximity according to the phase of the firm’s development process; splitting the process into different stages, something that is still not commonly done, reveals in particular the importance of social embeddedness and hence of social proximity during the formative phase. These concepts, together with the methodology, were taken up by Ferru (2010) in the Poitou-Charentes region. She confirmed the significance of the methods used to coordinate innovation actors and the structuring role of social networks on the geography of innovation. A comparison of areas also reveals that social relations in the Poitou-Charentes region have a less local dimension, suggesting that innovation collaborations are also less local.

A summary of these different empirical studies has been produced recently, and it brings to light consistencies when the effects of proximity and embeddedness are combined (Bouba-Olga et al., 2014, p. 236). It shows that ‘the creation of relationships between organizations based on interpersonal relationships is an effect of inter-individual relational proximity on the relational proximity between organizations. This effect partly explains the effects of geographic proximity.’ It also recalls ‘the decisive role of the structural characteristics of territories in the geography of collaborations.’ Despite their
many valid contributions, however, we should note that studies on embeddedness can have a tendency to overestimate the significance of inter-individual relations in economic activity (in the same way that Polanyi overestimates market autonomy).

5.4.2 Analysis of the Network and Modeling

Based on Boschma’s proximist typology (2005), several authors, economists and geographers have enhanced the empirical approach by suggesting the use of network analysis to measure the significance of the five forms of proximity. ‘We claim social network analysis is a promising tool for empirically investigating the structure and evolution of inter-organizational interaction and knowledge flows within and across regions’ (Ter Wal and Boschma, 2009, p. 739). This tool does indeed seem to be promising, and authors are using the relevant dynamic simulation models to formalize their analyses.

More specifically, in line with work on ‘small worlds’ (Milgram, 1967; Watts and Strogatz, 1998), some authors describe and model interaction structures (Jackson, 2008; Carayol and Roux, 2009; Massard and Mehier, 2009) and show that networks’ structural features (density of weak links, average distance between two nodes and so on) and the positioning of actors within the network (mainly via the concept of centrality) influence the performance of firms in general, and their capacity for dissemination and absorption of knowledge in particular (Ahuja, 2000; Giuliani, 2007; Morrison, 2008; Steiner and Ploder, 2008). Since the late 2000s, proximist authors have shown a growing interest in network analysis, which they use to account for the formation of innovation networks and the different forms of proximity at work. Massard and Mehier (2009) ‘especially focus on the relational and strategic dimensions of proximity by using some developments from social network analysis’ (p. 79) to explain accessibility to knowledge.

The Urban and Regional Research Center of Utrecht has been particularly active in the emergence and dissemination of this type of work, first with theoretical studies, with articles by Ter Wal (2009) and Boschma and Frenken (2010), then, more significantly, with empirical studies. These authors are ‘geo-economists interested in the effects of homophily (favoring the establishment of social relations or sharing information with those whose characteristics are similar to one’s own) for example, to explain the effects of synergy observed in local innovation systems’ (Maisonobe, 2013, p. 2). They use geolocation databases of individuals and their interrelations, from which they can identify collaboration networks and formalize network analysis. They explain the existence of social relations using the stochastic actor-based model SIENA (Snijders, 2001; Snijders et al., 2010).

Thus, in recent years, as highlighted by Maisonobe (2013, p. 2), ‘the SIENA model has been highly prized by members of the Proximity School’ as this tool seems particularly well adapted to the treatment of the question of the relative importance of the different forms of proximity (Ter Wal and Boschma, 2009). In the same vein, Balland (2010, p. 14) says that ‘entry via relational data allows the role of proximity at the individual level to be appreciated and constitutes a promising avenue of research into the proximity role.’

Balland et al. (2013a) have tested Boschma’s (2005) proximist typology specifically in the video game sector. Using a longitudinal database on the co-production of video games and an actor-oriented stochastic model, the authors studied how the five forms of proximity could potentially affect the formation of this collaboration network between
It appears that over time, firms in the video game sector have a tendency to favor partners that are physically closest and which are most similar in cognitive terms, highlighting changes in the effects of proximity in the course of the life cycle of the network. Using a similar methodology and in an attempt to evaluate the role of different proximities in the formation of innovation networks, many empirical studies have been undertaken since the end of the 2000s (Balland, 2010; Broekel and Boschma 2012; Hardeman et al., 2012; Balland et al., 2013a, 2013b, 2015a; Ter Wal, 2013; Boschma et al., 2014; Wanzenbock et al., 2015, among others).

From these empirical studies we have learned that controlling non-spatial forms of proximity tends to diminish the role of geographic proximity when actors join a network. Some studies also test the substitutable or complementary nature of proximities in forming innovation networks. For example, Ponds et al. (2007) study co-publications and show that geographic proximity can help overcome institutional differences between actors (university versus industry). Cassi and Plunket (2015), on the other hand, show that geographic and social proximities have a similar role and are substitutable when forming collaborations.

In an evolutionist approach, a dynamic perspective is introduced into the analysis to show how the influence of proximities changes over time. Some empirical studies have looked at the importance of time via longitudinal databases (see especially Hoekman et al., 2010; Balland et al., 2013a); ‘but even though these works make an important step by looking at whether the type of proximity explaining collaboration changes over time, the static logic in proximity approaches is essentially maintained, as proximity remains the driver of tie formation, and no attention is paid to the question whether the latter affects the former’ (Balland et al., 2015a, p. 911). This dynamic perspective is covered in a theoretical article by Balland et al. (2015a) that recalls the importance of complex interactions between proximities and especially the possible pre-existence of non-spatial proximities and their effects on geographic proximity. Thus, to avoid postulating a linear and unidirectional causality, we propose a dynamic extension of the proximity framework of Boschma in which we account for co-evolutionary dynamics between knowledge networking and proximity. For each proximity dimension, we describe how proximities might increase over time as a result of past knowledge ties (Balland et al., 2015a). In this way, a more realistic circular vision can be introduced. This co-evolution of proximities and knowledge networks happens when a long-term perspective is adopted, as proximities evolve less quickly than relations and networks. However, it is a complex task to validate this dynamic extension empirically and to measure interactions between all five forms of proximity.

This dynamic perspective requires a simplification of the forms of proximity. This, in our opinion, is the very reason for introducing the concepts of ‘related variety’ and ‘relatedness’ (Boschma and Frenken, 2011). By focusing on one form of proximity, cognitive proximity, these concepts ensure that it is possible to bring a dynamic perspective into proximity while removing the difficulties associated with incorporating the many possible interactions between the different proximity forms. This relatively recent literature plays a part in analysing the geography of innovation and enhances the study of externalities and clusters by insisting on one form of proximity, cognitive proximity, as confirmed by the following definition: ‘we define related variety as sectors that are related in terms of shared or complementary competences. In other words, some degree
of cognitive proximity is required to ensure that effective communication and interactive learning take place, although not too extreme, to avoid cognitive lock-in’ (Boschma and Iammarino, 2009, p. 294). The concept of relatedness is even synonymous in some cases with cognitive proximity – a proximity on which Boschma (2005) placed particular emphasis (see above) – and is defined and measured on the basis of similarity between two products or elements of knowledge.

Since 1999, Boschma had used these concepts ‘to identify clusters of innovative industries during the entire industrial period that were connected through dynamic processes of transfer and feedback of technology that crisscrossed a set of industries during a particular period’ (Boschma and Iammarino, 2009, p. 293). Boschma showed that ‘cognitive proximity between extra regional knowledge and the knowledge base of the region should be neither too small – avoiding lock-in in learning processes – nor too large – enabling the absorption of extra regional knowledge’ (Boschma and Iammarino, 2009, p. 295). The purpose of these studies was to explain why certain regions produce one specific type of knowledge rather than another and to show that new knowledge emerges when there is a solid base of pre-existing knowledge linked to it (Boschma and Frenken, 2011). Thus, territorial dynamics and the geography of innovation would be fundamentally structured by their degree of technological/sectoral relatedness. Mobilizing these concepts would then be a way of identifying opportunities for territories in terms of innovation and their degree of technological resilience.

Effects linked to variety and/or sectoral and scientific relatedness have recently been measured in relation to geographic proximity, with Boschma et al. (2009) testing the effect of related competencies on a firm’s growth and showing that this effect is modified when geographic proximity (regional recruitment) is included in the analysis. More precisely, they show that firms’ sector relatedness has a greater impact than geographic proximity when carrying out merger acquisitions. Ellwanger and Boschma (2013) refine this result using a database over a long period (in the Netherlands, at city level). They confirm the importance of sector relatedness in the appearance of mergers and acquisitions, but they also show the positive influence of geographic proximity when it is measured at a very detailed level (municipalities).

The concept of relatedness links a firm’s evolutionist approach, following on from Penrose (1959), to traditional industrial economic notions. It is indeed very similar to ‘technological proximity’ or ‘knowledge proximity,’ terms that have been widely used since the 1980s to analyse research and development (R&D) spillovers (Jaffe, 1986), technological diversification in industry (Breschi et al., 2003; Cantwell and Vertova, 2004) and how these are linked to product diversification (Pavitt et al., 1989), with Griliches (1979) having been one of the pioneers in measuring R&D externalities using technological proximity indicators.

### 5.4.3 Proliferation of Studies

The work developed by Boschma and his co-authors has proved useful in the methodological and empirical contribution it has made: in particular, they have made it possible to operationalize concepts of proximity. The advantage of network analysis is that it can be applied to any kind of data indicating a relation between two actors (Ter Wal and Boschma, 2011).
It is now possible and straightforward to duplicate this work as long as one has a sufficient quantity of dyadic data. Accordingly, ‘various kinds of data have been used to indicate knowledge networks’ (Balland et al., 2015a, p. 169), including knowledge sharing relations (Giuliani and Bell, 2005; Giuliani, 2007; Morrison, 2008; Broekel and Boschma, 2012), patent citations (Agrawal et al., 2006; Breschi and Lissoni, 2009), joint patents (Cantner and Graf, 2006; Hoekman et al., 2009), joint publications (Ponds et al., 2007, 2010; Frenken et al., 2009; Scherngell and Hu, 2011; Hardeman et al., 2012) and joint participation in R&D projects (Hagedoorn, 2002; Autant-Bernard et al., 2007; Maggioni et al., 2007; Scherngell and Barber, 2009; Ballard, 2012). Nevertheless, authors sometimes mention limitations associated with their data (Ter Wal and Boschma, 2011), pointing out that although interview data provide the most information, because interviews themselves are so time-consuming, it is impossible to obtain enough data extending over time and space (for more details on the limitations of data used to analyse a network, see Bernela and Levy (2015) discussing the virtually systematic hypothesis of complete graphs).

The proliferation of empirical studies applying the same model and the same methodology to different databases, yet which were accepted by peer review, is a factor of enrichment but also of saturation. It is enriching because the influence of proximities is tested on different territories, time spans and sectors. However, the very repetitive nature of these studies eventually takes the analysis down the path of diminishing returns. The method tends to take precedence over the aim of the research, the analysis, the network and over the model in general, in providing tools that can be reused over a set of databases (see above). There is a risk of losing sight of the whole purpose of the work in progress. The conclusions that could be drawn in relation to public policies are too often redundant (the limited role of geographic proximity) or too difficult to use (cognitive proximity is especially influential in phase 2 in one sector of activity and in phase 3 in another, but what can be done with this information? Should one modify or reproduce this characteristic? Why and how?).

This accumulation of barely innovative statistical studies on a given subject is not specific to empirical research on proximity. It has unfortunately become something of the norm in academic circles. It illustrates the general phenomenon of researchers being increasingly subjected to the ‘publish or perish’ rule, which impels them to produce work as quickly as possible, something that is easier to achieve with quantitative studies. The need to publish quickly and in great quantities (Parchomovsky, 2000; Fanelli, 2010) tends to standardize research strategies and encourage imitation (Insel, 2009) and hence research is repeated. This process does not favor a long-term scientific dynamic and emphasizes the need to bring in more intellectual creativity (Boyer, 2014).

The empirical literature on proximity, with its proliferation of articles and repetition of results, is not immune to this risk, which is why new avenues of research need to be explored.

5.5 EXPLORING NEW AVENUES

If we are to escape the problem of diminishing returns we must take risks and consider renewing subjects and methodologies, and pursuing some new avenues.
Here we put three up for discussion. They are by no means exhaustive, and others can be envisioned, as we suggest in the concluding section.

5.5.1 The Need to Take Representations of Proximity into Account

Rather than increasing the number of categories of proximity, with the risk of obscuring their interconnections, representations of proximity should be introduced. The proximity literature does tend to refer each category of proximity (geographic, relational, technological and so on) to its own specific objectivity. It is this that makes it possible to design a location diagram in which relationships between various types of proximity are weighted. Each one has its own objective content (kilometers (km) or time-km for geographic proximity, co-citations of patents for technological proximity, financial ties for organized proximity and so on) that influences the geographic configuration of innovation activity to a greater or lesser extent. Searching for an objective measurement of proximities serves to exaggerate this phenomenon. Economic agents act not so much according to the objective content of this or that proximity category but rather according to their perception of it. This is particularly true of geographic proximity, which is related not only to objective data (distance-time) but also to agents’ perception of distance. Thus, what is a distant relationship for some may appear as a close relationship for others and vice versa, with the result that the objective content of this distance is not necessarily significant for the proximity criterion.

The representation of proximity matters. For a long time, geographers have made use of this dimension of the mental perception of space, insisting on the differences between cognitive distance and real distance (see, for example, the summary review in Behavioral Geography produced 30 years ago by Bailly, 1985). This amounts to saying that geographic proximity is itself pluralistic and that it must be taken into account in order to know what part it plays in explaining the spatial forms of innovation processes. Aguiléra et al. (2014) define three forms of geographic proximity from completed questionnaires sent to 2000 Breton small and medium-sized enterprises (SMEs), asking them about relations with their main business partner. One called ‘real proximity’ is objective (kilometer thresholds), the other two are subjective: ‘perceived proximity’ is whether the firm has the impression that it is spatially close to its main partner; ‘active proximity,’ a sub-category of ‘perceived proximity,’ is when the firm says that spatial proximity has been instrumental in facilitating exchanges with the partner. It is interesting to observe the discrepancies between these three spatial proximities – 33 percent of firms located less than 50 km from their partner said that proximity had not played a facilitating role, while 30 percent of firms located further away (and sometimes in other countries) believe that proximity did play a part. Thus, perceived proximity can exist without it being active. As well as requiring explanation, these differences between real, perceived and active proximities show that any hasty assimilation needs to be reassessed.

Thus, in the literature, geographic proximity is assimilated with the existence of interactions: it is because agents are located close together that they are able to interact face to face. Aguiléra et al. (2014) turn the proposition around: it is because agents have social interactions (face-to-face relations) that they feel geographically close. This article shows that real proximity is only perceived and is certainly only active for firms that have face-to-face relations with their partner. Yet in the literature, it is futile to raise questions...
about the connection between geographic proximity and face-to-face relations as these two terms are equivalent; in fact, the type of social interaction determines the perception of geographic proximity and its activation.

With the representation of spatial proximity counting for more than physical proximity itself, what are its determinants? Studies carried out over the last 25 years seem to show that these determinants are organizational, relational and institutional interactions. Organizational through firms’ modes of organization, relational through embeddedness in social networks and institutional through the effects of proximity created by public policies. It is they that skew and shape our perceptions of spatial proximity through the routines and cognitive maps that they put in place. While the literature often takes as its starting point what geographic proximity does or does not allow when faced with other proximities, the real question is rather: in what way do interactions – organizations, social networks and institutions – create geographic proximity in economic activities, and in this case in innovation processes? From the moment that geographic proximity ceases to be physically objective and becomes a representation, it can no longer be considered as a prime factor accounting for geographic patterns since it is responding to social determinants (see above).

5.5.2 New Perceptions of Space-time: What are the Consequences for Studies on Proximity?

Studies on economic geography and proximity economics argue implicitly within the framework of a physical economy (legacy from the nineteenth century) steeped in knowledge (legacy from the twentieth century). Space is identified as a set of places where agents are located, between whom various types of externalities develop, each with a different spatial influence, and where reasoned development lies at the heart of innovation policies. However, two dimensions in this world have already changed.

First, spatial scales are no longer what they used to be: globalization affects not only the financing, design and creation of innovation but also the opportunities it opens up. Whereas previously it was possible to innovate in a local context and extend this framework gradually in successive stages, now the world’s frame of reference has leveled out: spatial scales remain, but the reference space has become global.

There is simultaneity in spatial scales: agents must work at different spatial levels at the same time. The register in which they act has been transformed, as has the way in which it is represented. Basically, the ‘geographic proximity versus non-geographic proximities’ question, which had been the founding issue of the Proximity School, assumed that a local action register was possible, a register crossed by non-geographic modes of coordination (the other proximities). Today, however, an agent must establish and coordinate his or her action simultaneously at several spatial scales (local, regional, national, international). The agent is both ‘here and elsewhere,’ they are ‘situated’ rather than ‘located,’ they are ‘here or elsewhere’ in space (Rallet and Torre, 2004). Local is no longer a form of territorialized economic activity that can be opposed to a deterritorialized form: rather, it is a territorial application of a global process. Geographic proximity relations are inseparable from global relations. They have to be considered as part of the same spatial set and not as opposing territorial forms. A locally embedded cluster cannot be understood without being inserted into a global economy. Support policies for clusters recognize
this but in practice they value local synergies unilaterally. Methodologies for evaluating clusters underestimate and sometimes ignore the role of global relations by taking into account only local interactions.

In this context, one might ask whether maintaining the ‘geographic proximity versus other proximities’ issue still has any meaning.

There is another transformation to take into account in our space-time relationship. Agents must not only situate their action at various spatial levels, but they must also be mobile. They are not necessarily where they were thought to be, that is, allocated to fixed locations. The presence in space of a researcher or an engineer must not be confused with the location of the establishment to which he belongs. This presence becomes multiform, occupying various places – another partner establishment, a transitional place such as a conference or a meeting, an intermediate urban location (a ‘third place’) and so on. In other words, there is a transitional mobility that has to be considered, which is different from the mobility that consists of substituting one fixed location for another fixed location. This form of mobility is growing rapidly, driven by the joint impetus of transportation and communication. A significant proportion of the population is not affected, but it plays an increasing role in coordinating agents, as it is their means of temporary proximity (Rallet and Torre, 2005; Bathelt and Schuld, 2008), especially in the field of innovation. Geographic proximity in space can therefore be achieved in some very different ways: permanent co-location, transfer for a certain length of time to a partner establishment, periodic or occasional meetings in intermediate places and so on. Temporary proximity blurs the maps of agents’ apparent locations while being very difficult to measure statistically. It has to be taken into account, however, and its impacts on the analysis of proximities analysed.

Having a multi-scale approach and taking temporary proximity into account are all the more important as innovation processes have become more complex and cannot be represented in a simple way (here versus elsewhere, local versus global). Firms and research centers carry out various innovation projects simultaneously, with partners that are themselves different, and which are located at different spatial scales. Hence, the following hypothesis: the location of a research unit (and its partners) is less important than the ability to start from a place and combine different spatial scales with different partners using means of communication (people and information) and societal supports (social networks, professional communities and so on). Innovation is based on the organization and management of a variable portfolio of relations with partners. By definition, it is impossible to manage this flexibility by reasoning in terms of location, that is, being physically anchored (an optimal location at time t will no longer be so at time t + 1). It is the ability to combine different spatial scales that is important. Places continue to be important, but because of the material possibilities that they offer agents to be able to combine the various spatial scales of their partnership relations: transportation and communication, professional connectivity platforms, infrastructure for meetings (trade exhibitions, fairs, third places, co-working areas etc.) and so on. Public policies must take this aspect into account.
5.5.3 The Resilience of Clusters and the Return of Territories

The ability of geographic clusters to reinvent themselves and endure over time is a question that has long been discussed (Courlet and Dimou, 1995). It has garnered renewed attention in recent years. On the one hand, researchers into proximity attach great importance to problems of long-term dynamics and the evolutionist approach that is used to understand them. On the other hand, a key issue for clusters is to be aware of factors that will enable them to escape diminishing returns and the effects of lock-in.

There are several possible ways to achieve this. The first arises from the need, as already pointed out, to move toward a dynamic approach to interconnections between various types of proximity, in order to avoid an over-determination of one type by another. Over time, the different forms of proximity co-evolve and are linked to one another, taking on more significance in certain phases of the processes studied. Searching for the most important form of proximity becomes a complex and somewhat futile exercise as the number of categories of proximity increases (see above). Another way of dealing with the dynamics of clusters is to explain points of bifurcation within the development trajectories of innovation networks (Menzel and Fornahl, 2009; Suire and Vicente, 2009, 2013; Neffke et al., 2011; Boschma and Fornahl, 2011; Crespo, 2011; Crespo et al., 2014, among others). Some of this literature overlaps the approach in terms of relatedness (Boschma et al., 2014; Crespo et al., 2014). Crespo et al. (2014) and Suire and Vicente (2013) have modernized the approach by using network analysis. They try to extract the structural properties of networks, pairs of terms in fact (information externalities/network externalities, hierarchy/assortativity, exhaustion/resilience), which determine cluster development. Structural indicators can be deduced from this to guide public policies. These indicators remain descriptive of a reality but without being able to explain its complexity, and in fact these studies do not clarify the territorial dynamics that underpin the clusters. The analysis deals with clusters by considering them as formal network structures rather than territorialized forms of innovation. These studies need further work, using qualitative data obtained from field work in order to interpret the value of the indicators obtained. It would seem necessary and even essential to go back to the territory in order to further the analysis.

To revisit the question of the territorial anchoring of clusters, we suggest two avenues of research, which presuppose a return to the notion of territory in industrial analysis. The first is based on the fact that nowadays innovations are born within ecosystems with a large territorial dimension. The notion of an ecosystem is much broader than that of a cluster: it includes non-industrial actors (consumers, communities and so on) alongside the industrial and institutional actors, which makes them more heterogeneous and creates many coordination problems before any innovation, which can be particularly disruptive, reaches the market. Territorial anchoring stems from the fact that local experiments are required to resolve these coordination problems and shape the ecosystem, with public policies supporting these experiments. The second avenue relates to the conditions in which creativity is able to emerge and reproduce in a territory. The creativity on which innovation ultimately depends is not intrinsic to a territory; it depends on the way in which a territory is organized. In the example of the Montreal video game industry analysed by Cohendet et al. (2013), creativity is linked to the ability of an intermediate layer (concert halls, various third places) to connect an underground layer of the city
(street artists, video practices by amateurs and so on) to its business, or upper ground, layer (major studios, video game publishers and so on). The territorial anchoring of innovation stems from the fact that urban proximity is a connector of different worlds.

As we pointed out at the beginning of this section, other avenues can be suggested. For example, few studies on proximity use organization theories to analyse the impact of organizational choices on the spatial distribution of innovation activity. The issue has mainly been approached from the standpoint of the functional coordination of innovation processes (for example, is physical proximity necessary to participate in such-and-such a phase of the innovation process?) or we have simply settled for a vague notion of organizational proximity. Organizational procedures must be examined in detail, with each type of procedure (coordination, supervision, inspection, incentives and so on.) being analysed with reference to whether or not it is able to produce forms of distance working when used in combination with technical supports (standards, certifications, communication technology and so on). This work has not been developed because organizational economists or sociologists have shown little interest in the spatial dimension of organizations. In the area of innovation, there is an interesting question: how do new organizational choices related to product and service innovation (open innovation, co-innovation and so on) impact the spatial configuration of the innovation process?

5.6 CONCLUSION

So what can we conclude in relation to the question posed in the title of this chapter, where we announced a review of a research trend started 25 years ago in the field of the geography of innovation?

It seems indisputable to us that returns are indeed diminishing. Output from studies in this field continues to be positive but is now of relatively minor importance. Minor in terms of intrinsic results (results are repetitive) and minor in terms of new lessons learned from these studies for public policies (but here repetition can have educational value). This will not prevent such studies from continuing. First of all, researchers will find new databases and/or new methodologies with which to verify or extend previous work. Second, the pressure to publish or perish will be an incentive to continue along this path as it is always easier to publish a standard paper on a recognized topic than to open up new areas of research.

Diminishing returns are explained primarily by the fact that the research program launched 25 years ago has largely achieved its objectives. Remember that its purpose was to challenge the supposed virtues of geographic proximity with regards to innovation activities and to reinstate these activities in a broader vision of the space where local and non-local relations are linked together. The analytical framework proposed in the 2000s gave rise to a number of empirical studies that have relativized the role played by geographic proximity and highlighted the importance of other essentially non-geographic proximities as supports for coordinating innovation activities. Public authorities still have to be convinced, but this is starting to happen by virtue of marketing work rather than by dint of new or original research. Nevertheless, the transfer of knowledge to political bodies is crucial, but is being done too late since researchers attach too little importance.
to it, and political bodies are often loath to incorporate disruptive ideas until they are no longer disruptive.

Avoiding diminishing returns, that is, an accumulation of studies that make only minor contributions, requires conceptual creativity. In Section 5.5 we outlined some ideas for renewal. They need to be clarified and there are certainly others to consider. Their common feature is that they move us away from taxonomic questions relating to various types of proximity, which provide no basis for answering the more fundamental questions posed.

Finally, the proximity framework can be usefully extended to other fields, in addition to the geography of innovation (Torre and Wallet, 2014), but that is another issue altogether.

Generally speaking, we advocate a return to conceptual enquiry, where qualitative analyses enable us to explore new questions and quantitative analyses are built around new problems. This is what was done 25 years ago, when the Proximity group was founded, and it is probably what must be done if we are to restart a research process with increasing returns. Issues surrounding the geography of innovation are certainly far from being fully understood.

NOTES

1. See, for example, ‘Approches multiformes de la proximité’ (Bellet et al., 1998), ‘La ville ou la proximité organisée’ (Huriot, 1998), Dynamiques de proximité (Gilly and Torre, 2000), Économie de proximité (Pecqueur and Zimmermann, 2004), Quelles proximités pour innover? (Rallet and Torre, 2007b), La proximité à l’épreuve des technologies de communication (Rallet and Torre, 2007a), Les Nouvelles proximités Urbaines (Rallet and Torre, 2008) and Regional Development and Proximity Relations (Torre and Wallet, 2014).
3. In 2008, Carrincazeaux et al. stressed that ‘many monographs have made it possible to validate the theoretical conceptualization of proximities but this type of empirical approach is generally taken with caution within the social scientists’ community’ (p. 624).
4. From 2008, Bouba-Olga et al. have also reflected on the future of the research group and its concerns, ‘Proximity, 15 more years? . . . one of the first challenges will certainly be to maintain the quality of the theoretical debates which have enhanced our meetings and will continue to do so . . . this will be achieved through contributions from beyond our borders’ (p. ?).
6. Groupe de Recherche sur les Milieux Innovateurs (Research Group on Innovative Environments) created in 1984 by Philippe Aydalot and directed by Roberto Camagni and Denis Maillat.
7. ‘The concept of proximity in five dimensions as defined by Boschma (2005) can thus be regarded as an extension of the evolutionary approach that focuses on cognitive proximity primarily: proximity is required in some (but not necessarily all) dimensions to get firms connected and to enable interactive learning and innovation among them’ (Boschma and Frenken, 2009, p. 121).
8. However, let us note that the risk of overlap increases with the number of proximities taken into account. In a dynamic perspective, the risk is all the greater when proximities are co-produced in time, so that it becomes difficult and a little futile to separate the influence of this or that form of proximity.
10. By focusing on one form of proximity, a dynamic perspective can be incorporated. This is also a constraint as it limits the analysis to one form of proximity, implying that some authors demonstrate the need to bring the literature closer in terms of relatedness to the proximist approaches (see Balland et al., 2015b).
11. In other instances, it is defined and measured based on the complementary nature of products or knowledge. This duality of definitions is clearly expressed in an article by Ellwanger and Boschma (2013) where the authors define the industrial ‘connection’ as referring both to similar or complementary economic activities.
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Part II  Relatedness and knowledge bases: introduction

Richard Shearmur, Christophe Carrincazeaux and David Doloreux

Knowledge plays a major role in explaining the geography of innovation. Of the Marshallian externalities, knowledge externalities are the principal explanation of the local dimension of innovation. Glaeser et al. (1992, p.1127), for instance, state in their seminal paper about growth in cities: ‘After all, intellectual breakthroughs must cross hallways and streets more easily than oceans and continents.’ This idea, that knowledge combination and diffusion is easier at the local level, has underpinned most of the 1990s literature and is generally based on the distinction between knowledge (tacit) and information (codified).

However, there is now a sizeable literature on knowledge categories and learning processes (see, for example, Amin and Cohendet, 2004). Critiques of this simple binary opposition and its geographical implications (Torre and Rallet, 2005) are now widely acknowledged (Bathelt et al., 2004): knowledge flows occur at different spatial scales simultaneously and the geography of knowledge is far from being a simple articulation between local (tacit) and global (codified) forms of diffusion (Bathelt and Cohendet, 2014).

The three chapters gathered in this part explore the link between knowledge and its geography by stressing different starting points (see confusions 1 and 5 in the general introduction to this volume) between the activity (the characterization of knowledge) and its context (the region). Each chapter proposes a specific mix between knowledge analysis and regions, and these are complementary.

Chapter 6 by Balland, with a strong methodological dimension, addresses the link between geography of innovation and knowledge through the concept of relatedness. The approach isn’t primarily spatial and is different from the related-variety approach, which is characterized as a regional approach. The starting point of the chapter is the characteristics of knowledge that support innovation – mainly relatedness: the idea of ‘knowledge space’ describes the degree of relatedness between different pieces of knowledge and the existing associations between them. When an entity is defined (a region, but this can also be a sector or a firm), it can be positioned within knowledge space and its likely trajectories and missing competencies can be analysed as a path-dependent process of knowledge accumulation and recombination. At a spatial scale, applying the concept of knowledge space shifts the question from trying to understand where innovation develops, to trying to understand what type of innovation will emerge in specific places. From a conceptual point of view, geography is defined by regions and borders and the proposed approach provides useful tools to guide regional technological policies.

In a more traditional way, Tödtling and Trippl focus on regions in Chapter 7, and argue that sensitivity to regional context requires attention to the characteristics of regions’
knowledge bases. Their approach is therefore directly oriented towards exploring the spatial dimensions of knowledge diffusion. Using the Synthetic-Analytical-Symbolic (SAS) knowledge categories to define sectoral contexts, they cross these knowledge categories with regional contexts (Metropolitan, Specialized and Institutionally ‘thin’) in order to infer the tendency towards local or global flows of knowledge diffusion. Based on several case studies in different regional and sectoral contexts, their analysis shows that public policy and firm strategies can influence, transform or adapt these regional contexts.

Finally, in this part, in Chapter 8 Aslesen and Isaksen explore the link between the nature of knowledge bases (also using SAS categories) and the local or global dimensions of interactions, first examining the nature of these interactions. Though the region (here operationalized as a cluster) is the study’s ultimate unit of analysis, the starting point is the activity itself and the spatial component of interactions. Their basic hypothesis is that the type of knowledge used implies different proximity constraints and types of partner. Based on an original survey of innovation cooperation between Norwegian firms, they show that firms’ different knowledge bases are associated with dominant partner types and locations.

These three chapters illustrate the range of dominant starting points and empirical strategies that can be adopted to explain why knowledge has specific geographies and how it flows at different spatial scales. Their common aim is to elaborate policy recommendations that make sense across diverse local situations and which acknowledge the necessary openness of ‘regional’ contexts.

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6.  Relatedness and the geography of innovation

Pierre-Alexandre Balland

6.1 INTRODUCTION

Scholars and policy makers consider that knowledge accumulation plays a major role in the growth and development of regions. But beyond economic growth, it is also seen today as the main engine of transformative change. How innovation and new technologies can be reoriented and used to deal with pressing societal challenges (especially climate change) is hot on the political agenda. During the past two decades, the geography of innovation literature has provided a rich and detailed account of the underlying processes of regional knowledge production. The geography of innovation literature rests upon the basic idea that knowledge production exhibits a particular geography (Feldman, 1994): but, more importantly for scholars embedded in this community, the spatial concentration of innovation activities and the persistent geographical proximity between organizations is not merely a fascinating empirical pattern. It is the key in understanding underlying processes of innovation (Asheim and Gertler, 2005). The geography of innovation literature has provided strong empirical evidence illustrating the role that spatial concentration and geographical proximity play for innovation (Boschma, 2005), how knowledge spillovers diffuse across space (Jaffe et al., 1993), the geography of innovation networks (Breschi and Lissoni, 2009) and their dynamics (Balland, 2012).

More recently, a growing body of empirical work has contributed to the geography of innovation literature by analysing the specific knowledge bases of regions and their evolution over time. The aim of these studies is not to explain why some regions produce more knowledge outputs than others (that is, number of patents), but why some regions produce a specific type of knowledge (that is, biotechnology). I shall refer to this body of literature as the relatedness literature. The geography of innovation basically asks: where does innovation take place? The relatedness literature takes a dynamic and historical approach and asks: why does this innovation take place in this region and not elsewhere? In this chapter I discuss the theoretical foundations of this literature, its methodological framework and recent empirical findings.

Based on evolutionary thinking, the spatial dynamics of knowledge are understood as cumulative, path-dependent and interactive. As a result, a main driving force is relatedness, as new knowledge is expected to branch out from related, pre-existing knowledge (Boschma and Frenken, 2011). This literature discusses how relatedness is shaping the geography of innovation. Empirically, the concept of relatedness has mainly been formalized as a network, as knowledge space (Rigby, 2015; Boschma et al., 2015a). This methodology builds on the paper of Hidalgo et al. (2007) in which they propose a network-based representation of the economy using export data. In the knowledge space network, nodes are knowledge categories, such as technological classes or scientific fields, and links between them indicate their degree of relatedness.

The empirical analysis of relatedness and knowledge space allows the knowledge bases
of regions to be mapped, explaining scientific and technological change, and identifying further opportunities for recombination and innovation. So far, the literature has mainly focused on descriptive and structural analyses of knowledge space, on systemic empirical analysis of the role of relatedness in the emergence of new knowledge across regions, on development of specific technologies/scientific fields, on the varying importance of relatedness across knowledge fields, on spatial or economic context and on whether the position of cities in knowledge space can explain innovation performance, technological resilience or can reveal the complexity of its knowledge bases. In this chapter I review this recent empirical work and discuss its implications for further academic research and innovation policy.

6.2 RELATEDNESS AND THE GEOGRAPHY OF INNOVATION

The literature on relatedness and related variety is mainly based on an evolutionary approach to economic activities and innovation (Boschma and Frenken, 2006, 2011; Frenken et al., 2007; Boschma et al., 2015). From this perspective, the evolution of knowledge in space and over time is the result of complex and non-linear dynamics, emerging out of interactions between actors that have heterogeneous capabilities. The dynamics of knowledge production and technological change are therefore conceptualized as a cumulative, path-dependent and interactive process. In this Schumpeterian view of innovation and technological change, new knowledge items do not emerge randomly, nor can they be produced in pure isolation. As Weitzman (1998, p. 333) put it, recombinant innovation is really about how ‘old ideas can be reconfigured in new ways to make new ideas’. Therefore, the reasoning behind the concepts of relatedness and related variety is that new knowledge is a recombination of old knowledge, though new knowledge is expected to branch out from related pre-existing knowledge (Boschma and Frenken, 2011).

So why does new knowledge tend to follow such path-dependent development, why does it branch out from related pre-existing knowledge? Knowledge dynamics, broken down at the global, national or regional level, are just a higher-order reflection of micro-level dynamics and behaviour of firms and other organizations. In fact, what we observe at the macro-level is the aggregate result of a search process, where actors look for existing knowledge, recombine it and provide new knowledge to other actors. But firms are heterogeneous in terms of capabilities and knowledge bases (Giuliani and Bell, 2005; Boschma and Frenken, 2006). They develop and accumulate specific routines that are persistent and difficult to replicate by outsiders (Nelson and Winter, 1982). This variety and heterogeneity of capabilities and knowledge bases give rise to different levels of cognitive distance and proximity among actors. Cognitive proximity refers to the degree of similarity of organizations’ knowledge bases (Nooteboom, 2000; Boschma, 2005) and is a critical dimension for communication and knowledge transfer between partners. Empirical analyses have shown that cognitive proximity is a crucial factor that drives the evolution of knowledge networks (Balland, 2012; Balland et al., 2013). Therefore, one is more likely to observe recombination of knowledge from related knowledge domains than from unrelated ones at the macro-level because firms and organizations from different fields lack cognitive proximity.

Relatedness and related variety express this idea, and both concepts reflect similar
evolutionary roots and underlying conceptions of knowledge dynamics (Boschma and Gianelle, 2014): but, to remain consistent, I shall mainly refer to relatedness rather than related variety in this chapter. The main difference between the two concepts, however, lies in their different units of analysis. Relatedness refers directly to the degree of relatedness between two knowledge items, such as two patent technology classes (Rigby, 2015; Boschma et al., 2014): so it is basically operating at the dyadic level, like the proximity concept (Boschma, 2005; Torre and Rallet, 2005; Carrincazeaux et al., 2008; Balland, 2012). Related variety, on the other hand, is an attempt to summarize and aggregate the ‘average’ relatedness of knowledge bases in a region (Frenken et al., 2007). So the unit of analysis is at the regional or group level, reflecting its technological composition, looking, for instance, at the portfolio of technological classes (Castaldi et al., 2014). In that respect, the related variety literature contributes to the diversity versus specialization debate (Beaudry and Schiffauerova, 2009; De Groot et al., 2009).

The idea that innovation and technological change can be understood as a cumulative, path-dependent and interactive process implies that knowledge dynamics are a spatial phenomenon. In fact, recombination can occur through different channels that tend to exhibit a strong spatial dimension. For the last two decades, the geography of innovation literature has provided many examples of the concentration of knowledge production and exchange (Audretsch and Feldman, 1996). A crucial feature of the different channels of knowledge transfer is that they generally take place at the regional level, leading to an uneven concentration and distribution of knowledge across space. Recent empirical studies confirm that collaborations are more likely to develop locally (Balland et al., 2013), but also that the mobility of knowledge workers and their social linkages are geographically bounded (Almeida and Kogut, 1999; Breschi and Lissoni, 2009). Interestingly, the movement of codified knowledge, such as technical knowledge contained in patents, also seems to display a strong geographical bias (Jaffe et al., 1993). It is increasingly recognized that in a knowledge-based economy, the localized nature of knowledge transfer also requires place-based innovation policy (Barca et al., 2012). The spatial dimension of the main channels of knowledge transfer implies that knowledge recombination trials (and successes) often occur in a spatial context, leading to a double mechanism of knowledge dynamics, which are both time-path and place-dependent (Heimeriks and Boschma, 2014).

Following this evolutionary approach it is clear that new knowledge tends to follow a place and path-dependent development, where new knowledge branches out from related pre-existing knowledge. Figure 6.1 illustrates this idea. Let’s assume for simplicity that the world consists of 11 knowledge domains (dark circles). Some are related (links between two knowledge domains), like K2 and K3, other are not, like K6 and K8. The region (delimited by the black circle) has 5 knowledge bases, from K1 to K5. The implication of relatedness and branching mechanisms is that the development of this region will be strongly biased towards knowledge diversification into K7 instead of K6, for instance. In fact, K7 is related to K1 and K4, which are both already in the region’s portfolio. This knowledge structure reflects the fact that many of the skills and capabilities required to produce K7 are already in the region. On the contrary, K6 is absolutely unrelated to the knowledge structure of the region, so it is very unlikely that this region will start producing K6.

The relatedness framework emphasizes that new knowledge tends to follow a
path-dependent development, where new knowledge branches out from related pre-existing knowledge. But what are the consequences of this idea for the development and growth of cities and regions? It basically means that new ideas, innovation or new technologies cannot just emerge anywhere in the world. On the contrary, new knowledge will systematically tend to emerge where pre-existing, related knowledge already exists. So relatedness is clearly shaping the geography of innovation. It also means that regions cannot easily make big jumps into new scientific or technological fields (Boschma et al., 2015). Investing in fashionable fields such as biotechnology or nanotechnology is a risky strategy if the region lacks related capabilities. Therefore, it is important to characterize regional knowledge structures, that is, to map the specific knowledge bases of regions and their degree of relatedness with external knowledge bases in order to reveal scientific and technological opportunities.

6.3 THE KNOWLEDGE SPACE

Empirically, the idea of relatedness in the geography of innovation literature has mainly been formalized as a network, the knowledge space, following Hidalgo et al.’s (2007) paper. Hidalgo et al. developed the product space framework, which is a network-based representation of the economy. In this network, the nodes define product categories and the ties between them indicate their degree of relatedness. The central idea, developed by Hidalgo and his colleagues to capture relatedness, is to look at how often two products are co-exported by countries. Relatedness is essentially operationalized using the same principles as Amazon’s ‘Customers Who Bought This Item Also Bought . . .’ algorithm. The disruptive business model of Amazon was to define products as related if they are frequently bought together instead of looking at traditional product classifications. This is the same idea with the product space, defining relatedness in an agnostic way, as an
outcome-based measure. The assumption behind the relatedness approach in product space is that if two products are co-exported by many countries, they most probably require the same capabilities (Hidalgo et al., 2007). So co-export is a reflection of the internal capabilities in a country.

Similarly, a knowledge network could be constructed by examining the co-production of similar knowledge domains, by evaluating if ‘regions that produce knowledge K1 also produce knowledge K2’. The technological or scientific fields K1 and K2 will be assumed to be related if they are often co-produced in the same regions: being successful in both implies that K1 and K2 probably require similar (unobservable) capabilities. Using this framework, one can construct the technology space, which is a network-based representation of the relatedness between all the technologies that can be found in a given patent dataset (Rigby, 2015; Boschma et al., 2014). Similarly, one can construct the scientific space, which in this case would be defined as a network-based representation of the relatedness between all the scientific domains that can be found in a given publication dataset (Boschma et al., 2014). For the sake of clarity, and also given the wide literature interested in innovation and technological change, I shall focus on the case of patent data to illustrate the construction of knowledge space.

Even though patented inventions do not capture all forms of invention and knowledge production, they contain a large set of information that has been extensively used for the analysis of knowledge creation and diffusion processes (Jaffe et al., 1993). For the study of technological change and knowledge dynamics, a key unit of analysis lies in the technology classes that are listed in patent documents. Patent data allow for the systematic analysis of the production of technological knowledge over time and across space, as several patent databases are publicly available for research purposes.

In this \( n \times n \) network, each node \( i (i = 1, \ldots , n) \) represents a specific technological class, as defined by the United States Patent and Trademark Office (USPTO), European Patent Office (EPO), Japan Patent Office (JPO) or other classification system. Indeed, patents are classified into one or more distinct technology classes that reflect the scope of the approved claims listed in a patent document. For instance, applying the measure to the three-digit USPTO main patent classes (Hall et al., 2001) gives a set of 438 different technological classes. According to Boschma et al. (2014), one of the biggest nodes in this network represents the technological class 800 (‘multicellular living organisms’), which is a sub-category of the biotechnology class. These authors compute the degree of relatedness between all 438 technologies by focusing on how often two technologies are found within the same US city (defined at the Metropolitan Statistical Area (MSA) level).

Following the approach proposed by Hidalgo and his colleagues, the relatedness measure \( \varphi_{i,j,t} \) is computed between each pair of technologies \( i \) and \( j \) by taking the minimum of the pair-wise conditional probabilities of cities patenting in one technological class \( i \) given that they patent in another technological class \( j \) during the same period. To avoid noise induced by minor patenting activity, authors generally focus on the primary technological classes listed on patent documents in which cities have a revealed technological advantage (RTA):

\[
\varphi_{i,j,t} = \min \{ P(RTA_{x_{i,t}} | RTA_{x_{j,t}}), P(RTA_{x_{j,t}} | RTA_{x_{i,t}}) \}
\] (6.1)
where a city $c$ has a RTA in technology $i$ at time $t$ if the share of technology $i$ in the city’s technological portfolio is higher than the share of technology $i$ in the entire US patent portfolio. More formally, $RTA_c(i, t) = 1$ if:

$$\frac{\text{patents}_{c,t}(i)}{\sum_c \text{patents}_{c,t}(i)} > \frac{\sum_i \text{patents}_{c,t}(i)}{\sum_c \sum_i \text{patents}_{c,t}(i)} > 1$$

(6.2)

Comparing changes in the knowledge space, authors tend to find that relatedness is persistent over time, which is consistent with the fact that knowledge recombination is a slow, gradual and path-dependent process (Kogler et al., 2013; Boschma et al., 2014). Figure 6.2 provides a visual impression of the technology space based on the average degree of relatedness for the entire period 1976–2010 as drawn by Boschma et al. (2015). This graph clearly shows that different technological classes tend to form interconnected groups that closely correspond to the classification in six main technological areas (Mechanical, Chemical, Drugs and Medical, Electrical and Electronic, Computers and Communications, Others) as proposed by Hall et al. (2001).

This approach is very efficient when one only has data on (1) a set of geographical units (cities, regions . . .) and (2) a set of knowledge categories (biotechnology, nanotechnology . . .). From the longitudinal observation of co-occurrence of knowledge domains in the same city/region only, it becomes possible to construct the knowledge space and analyse the spatial dynamics of knowledge over time. Now, of course, co-production of knowledge can capture much more than knowledge relatedness understood as a reflection of cognitive proximity between organizations. As acknowledged by Hidalgo et al. (2007), relatedness can reflect the need for similar institutions, infrastructure, physical factors, technology or a combination of these factors. So using such an outcome-based measure of relatedness for knowledge domains will not necessarily capture scientific or technological relatedness, but probably much more factors that lead to the co-production of knowledge domains. Depending on the research question, it might be useful to use a finer-grained measurement of relatedness. For the analysis of scientific and technological knowledge dynamics, relatedness can be measured from other sources.

Most of the time, patent documents list claims of novelty for different technological classes. In their work on the resilience of cities, Balland et al. (2015) use this information to construct the corresponding knowledge space. They measure relatedness between classes by looking at how often two technology classes co-occur on the same patent. These co-class counts have further been normalized by the product of the number of patents found in each of the technology co-classes, assuming a simple probability calculus (Van Eck and Waltman, 2009). As a result, the technological relatedness measure $\phi_{ij,t}$ indicates whether two technology classes $i$ and $j$ co-occur on individual patents more often than what can be expected by chance under the assumption that individual occurrences of patents in class $i$ and in class $j$ are statistically independent. Another strategy, following Rigby (2013), would be to use citations between classes to measure relatedness. Although these measures tend to be correlated, further research remains necessary to identify to what extent they differ, and to what extent they might capture different proximity dimensions driving knowledge exchanges (Balland, 2012).

So far we have been discussing the relatedness between two different knowledges
domains, but what interests many geography of innovation scholars is the position of cities in this knowledge space. What type of knowledge are cities producing? How related is the knowledge structure of a city to other knowledge domains? And to analyse knowledge dynamics, by which is meant technological or scientific change within cities and

**Figure 6.2 The US technology space**

Note: The US technology space is constructed using USPTO patent documents from 1976 to 2014. Each node (n = 438) represents a patent technology class (see Hall et al., 2001), and the links between these patent classes indicate their technological relatedness.

Source: Boschma et al. (2015).
regions, we need to construct a city-technology level variable that indicates how close a potential new technology is to the existing technological portfolio of a given city. This idea is operationalized by the density index (Hidalgo et al., 2007), which measures how close a new knowledge domain is to the existing set of knowledge in a given city. To continue with the example of patent-based analysis, the density around a given technology \( i \) in the city \( c \) at time \( t \) is computed from the technological relatedness of technology \( i \) to the technologies in which the city \( c \) has a relative technological advantage at time \( t \), divided by the sum of technological relatedness of technology \( i \) to all the other technologies in the USA at time \( t \):

\[
RD_{i,c,t} = \frac{\sum_{j \in \mathcal{J}_c} \phi_{ij} \times 100}{\sum_{j \neq i} \phi_{ij}}
\]

(6.3)

By construction, this relatedness density variable lies between 0 per cent and 100 per cent. A city-technology level density equal to 0 per cent indicates that there is no technology related to technology \( i \) in the city \( c \), while a value of 100 per cent indicates that all the technologies related to technology \( i \) belong to city \( c \)'s technological portfolio. Let's take again the example of Figure 6.1, a simple world consisting of 11 knowledge domains. In this case, K7 is related to two other domains K1 and K4. So the denominator will be equal to 2. Both K1 and K4 can be found in our region of interest, so the relatedness density between our region R1 and K7 is equal to \((2/2)*100 = 100\) per cent. By contrast, the relatedness density between R1 and K8 is only \((1/2)*100 = 50\) per cent. So following the evolutionary arguments developed in the theoretical section we would expect that our region is more likely to innovate in K7 than in K8. This empirical framework allows us to test to what extent relatedness is shaping the geography of innovation.

6.4 THE EMPIRICS OF RELATEDNESS

Scholars in economic geography have provided detailed accounts of how relatedness shapes the emergence of new knowledge and directs technological change (Best, 2001; Martin and Sunley, 2006). In his 2005 paper, Glaeser, for instance, explains how Boston has been able to reinvent itself over several periods of crisis by building on pre-existing knowledge domains. Boston was a major player in the shipbuilding industry, and this regional knowledge structure strongly influenced its further development. According to Glaeser (2005), these ‘skills with sailing ships enabled the city to reinvent itself as a global maritime center in the early 19th century’ (p. 122). In a similar fashion, Treado (2010) provides a detailed account of the technological trajectory of Pittsburgh. He shows how Pittsburgh has continuously built on strong pre-existing capabilities in the steel industry to develop new development paths to bounce back and achieve economic resilience. Taking a more explicit relatedness approach, Cooke (2008) shows that regions are not equal in their capacity to develop clean technologies. Building on several case studies, he shows that the green regional development that has occurred in regions of California, Jutland and Wales is the result of a complex process of convergence between different pre-existing knowledge bases related to biotechnology, information and communications technology (ICT), wireless, agro-food, agricultural and marine engineering.
Relatedness and the geography of innovation

Existing industrial and technological case studies tend to acknowledge the historical legacy of regions, emphasizing path dependence rather than random jumps from one technological field to another. The relatedness and knowledge space literature provides a methodological framework to test this idea systematically in quantitative empirical research. It asks whether relatedness is really shaping the geography of innovation (beyond specific cases), and by how much. Recent empirical studies have concentrated on five areas of research: (1) the descriptive and structural analysis of knowledge space; (2) the systematic empirical analysis of the role of relatedness in the emergence of new knowledge across regions; (3) the development of specific technologies/scientific fields; (4) the varying importance of relatedness across knowledge fields, space or economic context; and (5) whether the position of cities in knowledge space can explain innovation performance, technological resilience or reveal the complexity of its knowledge bases.

A first set of papers focuses on the structure and evolution of knowledge space. As knowledge space is the basis of many empirical analyses, it is important to understand how relatedness is constructed, what are the key knowledge domains (core/periphery), which knowledge categories tend to cluster together and how knowledge space evolves over time. In their paper, Kogler et al. (2013) map knowledge space and technological relatedness using USPTO patent data from 1975 to 2005. They compute technological relatedness between all 438 technological classes and describe the structure and evolution of knowledge bases of metropolitan areas in the USA. They show some variation in the structure of knowledge bases of cities (that is, the knowledge space of individual cities) but at the US level they conclude that the knowledge space is very stable over time. In that respect, it is clear that relatedness between technological classes is an enduring pattern (Boschma et al., 2014). Ballard and Rigby (2016) plot American cities in knowledge space, undertaking a 2-mode network analysis. They observe that cities are unequally distributed across knowledge space, with some being located in the core of knowledge space (San José), while others have a more peripheral location despite their size (Detroit). Instead of using patent data, Brachert and Broekel (2014) examine research and development (R&D) collaborations in Germany. Doing so, they explicitly focus on a specific dimension of relatedness, the complementarity of resources, and explore the structure and evolution of knowledge space (that is, complementarity space) using social network analysis techniques.

A growing number of studies have then used knowledge space to assess the role played by relatedness on the dynamics of technological knowledge in cities and regions. Boschma et al. (2014) test this idea for US cities using a three-way fixed-effects linear probability model (city, technology and year fixed-effects). They find that the entry probability of a new technology in a city increases by 30 per cent if the level of relatedness with existing technologies in the city increases by 10 per cent. Using the same USPTO patent data, Rigby (2013) finds similar results – using different econometric specifications and different relatedness measures – when he examines the role played by density of related technologies in a city with respect to further diversification. The same pattern has recently been documented for European regions (Kogler et al., 2016). Both papers also support the idea that relatedness tends to prevent the exit of technologies from a city. Boschma et al. (2014) report that the exit probability of an existing technology in the city decreases by 8 per cent when the level of relatedness with existing technologies increases by 10 per cent. These papers provide a systematic analysis of how relatedness is shaping
the geography of innovation and document the strong path-dependent trajectories of technological renewal in cities (both for entry and exit mechanisms).

While the above-mentioned studies investigate the emergence of technologies in general, other work has focused on specific cases. A typical question is: why did ICT massively emerge in Silicon Valley and not elsewhere? Such empirical studies also focus on patent data for high-income countries such as the USA and Europe. For instance, Colombelli et al. (2014) ask why nanotechnology entered the portfolio of some European regions and not others. Focusing on the patenting activity of regions in 15 European countries at the NUTS 2 level, they identify the set of technologies that are related to nanotechnology in knowledge space, look at their spatial distribution within Europe and find that nanotechnology systematically emerges in regions with pre-existing related knowledge bases. The literature also provides strong evidence of the role of relatedness in shaping the spatial dynamics of fuel cell industries in Europe (Tanner, 2016) and of the spatial diffusion and adoption of recombinant DNA (rDNA) technological knowledge in the USA (Feldman et al., 2015). This is also the case for technological classes developed for mitigation or adaptation against climate change (Van den Berge and Weterings, 2014), confirming the qualitative studies of Cooke (2008) relating to the unequal capacity of regions to develop clean technologies. All the above studies focus on patent data, but recent analyses have also been conducted using scientific publications. Combining scientometric techniques with the knowledge space approach, Boschma et al. (2014) analyse the emergence of 1028 scientific topics in biotechnologies worldwide at the city level. In all cases, these studies agree on the important and positive role played by relatedness.

More recently, a few studies have started to investigate the role of relatedness in different scientific and technological contexts. Heimeriks and Balland (2016) investigate whether relatedness plays the same role in the spatial dynamics of four different fields in cities at the global level between 1996 and 2012. While they still identify a positive role for relatedness in all fields, that is, astrophysics, biotechnology, nanotechnology and organic chemistry, they also find remarkable differences in terms of magnitude. For instance, astrophysics is the most path and place-dependent field, while the spatial dynamics of biotechnology knowledge is more difficult to predict. They explain these differences by the heterogeneous levels of task uncertainty and mutual dependence6 (Whitley, 2000). Besides differences across scientific fields, the work of Petralia et al. (2015) investigates patterns of technological diversification at the country level. By interacting countries’ gross domestic product (GDP) per capita with a variable measuring the distance of a new technology to each country’s technological portfolio, they find that relatedness plays a more important role during the early stages of economic development. So, as they develop, countries are better able to make longer technological jumps.

A last set of studies analyses how the position of cities in the knowledge space influences innovation performance, explains technological resilience or reveals the complexity of their knowledge bases. This line of research is an attempt to use information on the knowledge space to characterize the knowledge structure of cities.7 Rigby and Van Der Wouden (2012) show in their paper that higher levels of average relatedness (that is, technological coherence) in cities increase the rate of invention using patent data. The main argument is that more relatedness within a city can boost efficient knowledge transfer and further productivity in knowledge production. However, such a position can also be detrimental in the long run, as it can reduce the scope of knowledge available and
further opportunities for recombination and diversification. Taking a different angle, Balland et al. (2015) analyse the resilience of cities as their relative capacity to sustain the production of technological knowledge in the face of adverse events. Their empirical results suggest that cities with a high degree of relatedness to technologies in which they do not currently possess comparative advantage tend to avoid technological crises (defined as periods of sustained negative growth in patenting activity), have limited downturns in patent production and faster recovery. In another fashion, Balland and Rigby (2016) plot American cities in knowledge space and, using the method proposed by Hidalgo and Haussmann (2009), map the distribution and evolution of (technological) knowledge complexity in US cities. Looking simultaneously at the range and ubiquity of technologies they develop, the authors show that knowledge complexity is unevenly distributed across the USA and that cities with the most complex technological structure are not necessarily the ones with the highest patent per capita rates.

6.5 CONCLUSION AND AVENUES FOR FUTURE RESEARCH

A growing body of empirical literature in the geography of innovation has recently analysed the specific knowledge bases of regions and their evolution over time. This literature does not focus on how much a region is producing, but what a region is producing and why. The underlying theory is evolutionary: regions diversify into new technologies by building upon related, pre-existing knowledge. In this chapter I have discussed the theoretical foundations of this literature but also its methodological framework: the knowledge space. This network-based representation of the knowledge structure of cities is a way to formalize the concept of relatedness, and to systematically test its implication for the evolution of the geography of innovation. A review of recent empirical findings reveals that there is now a consensus that relatedness plays a key role in shaping the geography of innovation, for different regions in the USA and Europe, and for a variety of technological fields.

Such a consensus is not common in economic geography, as the field encompasses many debates (Boschma and Frenken, 2006). In particular, empirical evolutionary approaches and more qualitative institutional approaches seem to converge on this point. Does this mean that we have now enough empirical evidence to implement a sound policy framework? This is what is argued by Boschma and Gianelle (2014), for instance. Mapping the knowledge space of regions would be very informative for policy makers as it would then be possible to evaluate what kind of technological developments are within reach (closely related to pre-existing knowledge) and which are risky jumps (far from the skills and competences of the region). Coupled with indicators on the economic value, or quality, of these technological opportunities (Balland and Rigby, 2016) it becomes possible to evaluate the potential benefits of more or less related diversification. In fact, it could be the case that a region has all the knowledge needed to develop a given technology, but that there is no economic interest in doing so (for instance, if this technology is already produced by many other regions, that is, very ubiquitous).

This empirical consensus does not mean that there are no challenges or open research agendas on this topic. It reflects the adoption by many scholars of a sound conceptual (relatedness, regional branching) and methodological (knowledge space) framework with
important implications for innovation policy. But clearly, it is important to emphasize that most empirical studies so far have analysed how relatedness shapes the geography of innovation using very similar data sources and quantitative approaches. The knowledge space framework has mainly been used to analyse (1) the development of new scientific or technological knowledge; (2) based on patent data; (3) for a very recent period; (4) in the USA or Europe. It still represents a particular spatial dynamic of knowledge. It is important to know if relatedness plays a different role in developing countries than in developed countries, in a context of economic crisis, across different knowledge domains (more or less complex), at different points of the life cycle of the field considered, or according to different institutional settings and political regimes. Virtually all these important questions remain open.

Despite the fact that relatedness and knowledge space clearly mark the beginning of a new research line, one of the most fundamental questions is still unanswered. What is relatedness? In their paper on product space, Hidalgo et al. (2007, p. 484) explicitly state that they ‘take an agnostic approach and use an outcomes-based measure, based on the idea that, if two goods are related because they require similar institutions, infrastructure, physical factors, technology, or some combination thereof, they will tend to be produced in tandem, whereas dissimilar goods are less likely to be produced together’. Despite all the advantages of this approach, it is pretty much the definition of a black box. Is it time to open this black box? Could we learn from the analytical distinction proposed by the proximity school to define different forms of proximity (Bellet et al., 1993; Rallet and Torre, 2001; Boschma, 2005; Carrincazeaux et al., 2008; Balland, 2012)? It is an urgent question, since many scholars are now proposing different ways to measure relatedness, from job mobility to patent co-classifications.

Finally, an important and basic question for those focusing on relatedness is where does relatedness come from? Empirically, it is revealed by the dynamic analysis of knowledge space. Empirical studies so far have shown that knowledge space is quite stable from one period to another (Kogler et al., 2013; Boschma et al., 2014). But these studies analyse, in general, short periods of time (for patent data, mainly since 1975) and aggregate technological categories. A key question is how this knowledge space changes over time. What are the driving forces that shape the creation or dissolution of related ties (or increases/decreases relatedness)? Who are the actors that bridge unrelated knowledge and generate breakthrough innovations leading to new technological paradigms? The question of what makes two previously unrelated knowledge domains related in the next period is still left unanswered. This question could be tackled by using recent theories and statistical models that have been proposed to analyse the spatial dynamics of inter-organizational knowledge networks (Balland, 2012).

NOTES

1. Related variety does not necessarily apply to a region: it can apply to any group. In the context of the geography of innovation, it is applied to regions or to groups of economic actors within a region.
2. Class 33 listed in Hall et al. (2001).
3. Rigby (2013) also found a strong correlation between the classification of Hall et al. (2001) and a relatedness graph constructed from patent citations.
4. Besides the geography of innovation, there is a vast literature analysing industrial dynamics in regions from
the relatedness framework. The knowledge space literature is largely building on these studies: Neffke et al. (2011), Essletzbichler (2013), Boschma et al. (2013).

5. A 2-mode network consists of two different types of nodes, in this case cities and technologies. This specific network structure is also referred to as bipartite, bimodal or an affiliation network in the network literature. Typical examples of 2-mode networks are individual-event networks, interlocking directorates, predator-prey networks or firm-projects networks.

6. Task uncertainty concerns the unpredictability of task outcomes, while mutual dependence measures the dependence on other researchers in order to make a significant contribution.

7. In that respect it comes close to the related variety literature (Frenken et al., 2007).

REFERENCES


7. How do firms acquire knowledge in different sectoral and regional contexts?

Franz Tödtling and Michaela Trippl

7.1 INTRODUCTION

There is widespread agreement in the literature that innovation processes are open and interactive in nature (Lundvall and Johnson, 1994; Chesbrough, 2003; Laursen and Salter, 2006; Tödtling et al., 2013). Due to the highly specialized and dynamic character of the knowledge economy firms increasingly rely on various kinds and combinations of external knowledge (that is, knowledge that is not available within their boundaries) to bring forward innovations (Giuliani, 2011). Previous studies have shown that innovation processes and the type of knowledge needed differ strongly between industrial knowledge bases (Asheim and Gertler, 2005), although such patterns have turned out to be more complex than initially proposed. Recent research suggests that, particularly for more radical innovation, a broad search for knowledge, combinations of knowledge bases and integration of knowledge from various spatial scales are beneficial (Asheim et al., 2011; Laursen, 2012; Manniche, 2012; Strambach and Klement, 2012; Grillitsch and Trippl, 2014; Grillitsch et al., 2015).

The ability of firms to acquire external knowledge depends on various conditions such as the transferability of the knowledge in question as well as its availability at the firm’s location (Chaminade, 2014). The transferability of knowledge differs between knowledge types such as tacit/codified or synthetic/analytic/symbolic knowledge (Asheim et al., 2011). Knowledge that has a more tacit character or is dependent on social and cultural contexts – such as symbolic knowledge – is strongly tied to particular locations, whereas knowledge that is easy to codify and is less dependent on particular contexts is more mobile across geographical space. Different mechanisms can be used for transferring such knowledge types (Tödtling et al., 2006): market-based relations and formalized cooperations are more appropriate for transferring well-defined and codified knowledge, whereas knowledge spillovers and informal networks are adequate channels for transferring tacit knowledge.

Geographical proximity to potential knowledge sources and innovation partners enhances the local availability of knowledge in specific fields. Companies find it easier in some locations than in others to access, in particular, tacit and context-dependent knowledge and to interact with relevant actors. Regions with a high density and diversity of firms, knowledge organizations and support agencies offer more opportunities for sourcing and combining different kinds of knowledge than highly specialized industrial areas or peripheral ‘organizationally thin’ regions (Tödtling and Trippl, 2005; Isaksen and Trippl, 2014a). There are also other proximities that matter for knowledge interaction such as cognitive, social and institutional proximities (Boschma, 2005; Breschi, 2011). To some extent these other proximity types overlap with geographical proximity, but they...
How do firms acquire knowledge in different sectoral and regional contexts?

can also be independent from it as the growing importance of global innovation networks and professional or virtual communities demonstrate. Proximities may also change over time as an outcome of knowledge linkages (Balland et al., 2015).

In advanced knowledge economies companies only partly rely on local knowledge sources. They often also acquire knowledge through various mechanisms at the national, international and global scales (Powell and Grodal, 2005; Maskell et al., 2006; Bathelt, 2011; Giuliani, 2011; Chaminade, 2014). This implies that knowledge sourcing is a multi-scalar process that enables companies to cope with locational disadvantages. Reaching out to new knowledge sources is often needed, particularly for more radical innovations that benefit from the combination of various knowledge bases and integration of knowledge from different spatial contexts (Tödtling et al., 2009; Strambach and Klement, 2012; Grillitsch and Trippl, 2014; Tödtling and Grillitsch, 2015).

The aim of this chapter is to review and synthesize recent conceptual and empirical contributions on the nature and geography of knowledge sourcing activities. It is argued that two essential factors – the transferability and availability of knowledge (see also Chaminade, 2014) – have a strong explanatory power in this regard. We provide a systematic view of patterns of knowledge sourcing by focusing on industrial knowledge bases (sectoral contexts), which differ enormously with respect to the transferability of their key knowledge types and regional innovation systems (regional contexts), which vary substantially in terms of knowledge availability. The chapter is organized as follows. Section 7.2 presents a conceptual framework that seeks to explain the geography of knowledge sourcing activities in different sectoral and regional contexts. Section 7.3 reviews some empirical evidence relating to these patterns for a variety of industries and regions. This is followed by a discussion and comparison of the empirical cases in Section 7.4. Finally, Section 7.5 concludes.

7.2 CONCEPTUAL FRAMEWORK

The industrial knowledge base approach highlights that innovation processes as well as knowledge sources vary strongly between sectors (Asheim and Gertler, 2005; Asheim et al., 2011; Martin, 2013). This approach distinguishes between analytic, synthetic and symbolic knowledge bases. It is argued that these three types of knowledge bases contain different mixes of tacit and codified knowledge, which has implications for the transferability of the critical knowledge input on which innovation activities are based (Asheim et al., 2011). Codified knowledge is much easier to transfer, whereas tacit knowledge is often tied to geographical, cultural and social contexts. Sectors are regarded as being dominated by a particular knowledge base, although we often find mixes of them (such as in information and communications technology (ICT), automotive and new media; Halkier et al., 2010). Recent research suggests that combinations of knowledge bases are most conducive to innovation. In particular, more radical innovations (Tödtling et al., 2009; Strambach and Klement, 2012) and the creation of new industry paths (Asheim et al., 2011; Isaksen and Trippl, 2014a) often rely on the integration of knowledge from different spheres such as business, science and arts, and on knowledge from different geographical contexts (Bathelt, 2011; Tödtling and Trippl, 2013).

With regard to the role of regional contexts for knowledge sourcing and innovation
processes, several competing approaches can be found. Some scholars argue that the idea of a continuous geographical space (instead of fixed territories or spatial scales) should be applied in analyses of knowledge links and networks (Bunnel and Coe, 2001; Bathelt, 2011). However, based on the argument that institutional settings and policy competencies can have a strong impact on innovation, we consider regional (and national) innovation systems as useful concepts for our analysis (Doloreux, 2002; Cooke et al., 2000, 2004). This can be justified on the ground that innovation in firms and clusters can benefit from a strong availability of knowledge in the region, brought about by a critical mass and diversity of firms, universities, research centres and various types of supporting organizations. In addition to the degree of organizational thickness of places, institutional preconditions (or institutional thickness, Zukauskaite et al., 2014) such as favourable regulatory settings, values, habits and routines also matter for innovation. Taking these insights as a starting point, and based on earlier work, we distinguish between three types of region to examine the role of regional contexts for knowledge sourcing: diversified metropolitan areas, specialized industrial regions and peripheral, organizationally ‘thin’ areas (Tödtling and Trippl, 2005; Isaksen and Trippl, 2014a).

Combining the two dimensions – that is, the transferability of knowledge (sectoral contexts) captured by the knowledge base approach and the availability of knowledge (regional contexts) captured by the innovation system approach – enables us to identify more and less favourable settings for sourcing specific types of knowledge (Table 7.1). Metropolitan regions offer the best preconditions for accessing symbolic as well as analytical knowledge. Symbolic knowledge is most dependent on local contexts due to its highly tacit nature and its reliance on social and cultural patterns (Power and Scott, 2011; Martin, 2013). Metropolitan areas are often among the creative and cultural hotspots and they attract creative people in various fields (Florida, 2005). They also offer good conditions for accessing analytical knowledge since they are usually well endowed with excellent universities and research organizations. Although analytical knowledge is to a large extent highly codified in nature, it still depends on tacit capabilities to access and use it. Face-to-face interaction can be important in certain phases of R&D projects. In addition, metropolitan regions usually have a well-developed transportation and ICT infrastructure, allowing for easy access to knowledge and interaction with innovation partners at higher spatial scales.

Specialized industrial regions offer good preconditions for accessing synthetic knowledge that is often tied to specific local industries such as steel, engineering, automotive,

Table 7.1  Sectoral and regional contexts for knowledge sourcing

<table>
<thead>
<tr>
<th>Types of knowledge and their spatial character</th>
<th>Analytical knowledge: local-global</th>
<th>Synthetic knowledge: multi-scale</th>
<th>Symbolic knowledge: local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metropolitan regions</td>
<td>++</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Specialized industrialized regions</td>
<td>0</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>Institutional ‘thin’ regions</td>
<td>--</td>
<td>0</td>
<td>--</td>
</tr>
</tbody>
</table>

Note: Contexts for knowledge sourcing: ++ excellent; + good; 0 neutral; − unfavourable; − very unfavourable.
machinery and materials. Synthetic knowledge has a partly tacit character in the form of worker and firm experience, and a partly codified one when it is embodied in machinery, software and licences. Synthetic knowledge is frequently exchanged with customers and suppliers that are to some extent located in the region but also at higher spatial scales (Tödtling et al., 2006). Such knowledge from the value chain is important but it may lead to incremental innovation only (Tödtling et al., 2009) and may support existing technology and industrial paths (Tripl and Tödtling, 2008; Isaksen and Tripl, 2014a). Industrial regions may host organizations providing specialized analytical knowledge (like universities, colleges or research organizations with a strong orientation towards the region's industrial structure). For symbolic knowledge specialized industrial regions are rather unfavourable: this type of knowledge is tied to creative people who are rarely attracted to such areas. Also, traditional industries are usually not very engaged in symbolic knowledge base activities, leading to limited interaction potential for new creative firms that may settle in such areas. However, there is also evidence that this type of region can undergo major restructuring and diversification processes (as observed in some former ‘old’ industrial regions; Tripl and Tödtling, 2008; Tripl and Otto, 2009), leading to better conditions for the emergence and growth of symbolic industries.

Peripheral and organizationally ‘thin’ regions have some possibilities to source synthetic knowledge through their value chain relationships with customers and suppliers outside the region. However, they also require internal capabilities for absorbing such external knowledge, as Grillitsch and Nilsson (2015) have shown in a study for European regions. In terms of analytical knowledge, they face worse conditions since there are usually rather few universities and research organizations within the region. There are only a few examples of peripheral regions that host analytical sectors with intense regional knowledge flows (Isaksen and Tripl, 2014b). Companies, therefore, are forced to source analytical knowledge at higher spatial scales. This may happen inside the organizational context of multi-locational firms or through research and development (R&D) and innovation cooperation with external research organizations and firms. With regards to symbolic knowledge, peripheral regions face even more difficulties since this type of knowledge is usually concentrated in larger cities (Lazzeretti et al., 2008; Lorenzen and Frederiksen, 2008; Power and Scott, 2011) and characterized by limited transferability due to its tacit and context-dependent nature. Ways to acquire it would be through recruitment of qualified personnel, cooperation or taking part in project-based networks or communities.

7.3 EMPIRICAL FINDINGS

In this section we draw on cases from Austria, Finland, Germany and Sweden to examine the pattern of knowledge sourcing in different sectoral and regional contexts. These countries are comparable in terms of their institutional and policy models (Hall and Soskice, 2001). The cases presented below were originally analysed within the European ‘Constructing Regional Advantage Project’ (CRA) (Asheim et al., 2011; Tödtling et al., 2013). We use them as an empirical basis since a similar framework for investigating knowledge sourcing activities has been applied. These cases are complemented by other relevant literature. The questions to be addressed in this section are: Which knowledge sources at what spatial scales matter for innovation? Which kinds of mechanisms (or
7.3.1 Knowledge Sourcing in Analytical Sectors: Biotechnology in Vienna and Aachen

Studies focusing on the analytical knowledge base often refer to biotechnology, nanotechnology, new materials or ICT. Although there are many regional case studies on life sciences and biotechnology, only a few have examined knowledge sourcing activities in a systematic way (Gertler and Levitte, 2005; Trippl and Tödtling, 2007; Moodysson et al., 2008). Studies that have used a comparable frame have been carried out for the metropolitan regions of Vienna (Tödtling and Trippl, 2010), Prague (Blazek et al., 2011) and the formerly industrialized region of Aachen in Germany (Plum and Hassink, 2011).

The metropolitan region of Vienna has both strengths as well as weaknesses for developing a biotechnology cluster. The city is the core scientific centre in Austria and is well endowed with universities and research organizations in various medical fields. However, the Austrian as well as the Viennese innovation systems lack funding and venture capital when compared to leading biotechnology regions and countries. Vienna is therefore a latecomer in this industry and the cluster is not yet strongly developed (Trippl and Tödtling, 2007). The arrival of international firms such as Böhringer-Ingelheim and Baxter a few decades ago has strengthened the local knowledge base. Spin-offs and start-ups grew since the 1990s, partly supported by specific policies. Since Vienna is the dominant location for biotechnology in Austria with about 70 per cent of sector employment, the observed knowledge relationships have a clear local-global pattern. At the regional level companies interact with research organizations from academia in both formal and informal ways (Tödtling and Trippl, 2010). Knowledge links to local firms specialized in the provision of testing services and instruments (synthetic knowledge) also matter. At the same time, formal R&D cooperation with international research centres and firms is eminently important for them. Thus, biotechnology firms in Vienna combine analytical and synthetic knowledge sourced from both the local and global levels.

Most biotechnology clusters can be found in metropolitan areas with a strong analytical knowledge base. Only a few of these clusters are located in less favourable regional contexts. The emerging biotechnology sector in Aachen, a former ‘old’ industrialized region in North-Rhine Westphalia (NRW) in Germany is a good example in this regard. The rise of this sector can be traced back to the mid 1990s, when the ‘Aachen Technology Region’ was among the winners of Germany’s ‘Bioregio’ contest. National funding in the context of this initiative proved to be essential for strengthening the knowledge infrastructure and other preconditions for biotechnology. Hassink and Plum (2011) have shown that non-local knowledge sources play a major role for Aachen’s biotechnology firms. This reflects the rather unfavourable regional context and limited availability of knowledge within the region. Companies frequently engage in R&D cooperation with German or international universities and research organizations, emphasizing the analytical knowledge involved. In addition, they rely on various forms of international knowledge spillovers. The structure of relationships reveals that ‘interactive learning among biotechnology firms within the region is, so far, very rare . . . Firms that might keep the potential function as gatekeepers typically do not diffuse relevant . . . knowledge through the investigated cluster’ (Hassink and Plum, 2011, pp. 1153ff.).
A comparison of the geography of knowledge sourcing activities in the Viennese biotechnology cluster and its counterpart in Aachen uncovers the importance of regional contexts and differences in the local availability of knowledge. Both clusters are globally connected to international research organizations and firms. In the metropolitan Vienna region, however, we also find an intensive knowledge exchange at the local level, while in Aachen such processes are almost absent due to the limited availability of knowledge sources within the region.

7.3.2 Knowledge Sourcing in Synthetic Sectors: ICT and Machinery in Austrian and Finnish Regions

From the many sectors based on synthetic knowledge, we have selected the ICT sector that cuts across several knowledge bases and combines analytical, synthetic and symbolic knowledge (Halkier et al., 2010). However, most often innovations are based on synthetic knowledge in this sector. The Austrian regions included in our review represent three different types of RIS: a metropolitan RIS (Vienna), a specialized industrial RIS (Upper Austria) and an organizationally ‘thin’ RIS (Salzburg). In the ICT and software sector in the metropolitan region of Vienna we find both hardware and software firms that differ in their knowledge bases, patterns of innovation and knowledge sourcing. Hardware firms are larger, have more R&D and they more frequently introduce ‘products new for the market’ (Tödtling et al., 2011). As a consequence, they also rely more often on knowledge drawn from universities and research organizations, both within the region and beyond. Software firms are mostly small, innovate without R&D and adapt existing technologies to the local market (Trippl et al., 2009). Customers, suppliers and competitors are thus most relevant as knowledge sources for software firms. Relations with these sources are informal and formal and they can be found both at the regional and global levels. For the whole ICT sector strong knowledge links to local and Austrian universities also prove to be important. Local universities, for instance, play a key role as providers of highly skilled graduates and as cooperation partners in R&D projects. Overall, Viennese ICT firms benefit, in their knowledge sourcing activities, from a strong availability of analytical knowledge, which is typical for metropolitan regions.

The ICT sector in Upper Austria, an industrial region, cannot rely on such a strong R&D base and high firm density as its counterpart in Vienna (Tödtling et al., 2012). Upper Austria is specialized in steel, materials, engineering, vehicles and environmental technologies. It has, however, a relatively well-networked regional innovation system (RIS) that includes a few universities and technical colleges, a large software park, several technology centres and some R&D-intensive firms. The region’s ICT companies are more often in the software sector, and they mainly generate incremental innovations. Due to the networked character of the RIS, we find high levels of regional collaboration with universities and technical colleges. In addition, suppliers of hardware and software components located outside the region are important knowledge sources. ICT firms in Upper Austria thus benefit from a well-networked RIS and from knowledge sourcing activities at higher spatial scales.

The ICT sector in the organizationally thin RIS of Salzburg faces more disadvantages. The regional context is rather unfavourable. Universities located in the region are few and small, firm density is low and the labour market is small. Firms are on average
smaller, less R&D intensive and also less innovative than the firms in Vienna or Upper Austria. Key knowledge sources are customers, suppliers and competitors at national or international levels, regional and Austrian universities, and regional technology centres. Formal relationships such as R&D contracts and technology purchases tend to prevail. Consequently, innovative firms compensate locational disadvantages and the weak availability of knowledge in the region by sourcing knowledge along the value chain and from partners outside the region.

For the synthetic knowledge base we can furthermore draw on the Finnish cases of intelligent machinery in the industrial region of Tampere and agro-technology in the peripheral and organizationally ‘thin’ region of South Ostrobothnia (Sotarauta et al., 2011). The heavy machinery cluster is located in Tampere, a medium-sized town with a long industrial tradition. The machinery industry there has faced difficulties in the past but was able to restructure, partly through enhanced innovation capabilities and through intensive cooperation with knowledge-producing organizations such as the Tampere University of Technology and the VTT Technical Research Centre of Finland. There are now some world leading intelligent machinery companies in the region and Tampere is also a major location for machinery research. ‘The competitiveness of the cluster is based on adding “intelligence” to traditional machines’ (p. 1312). As regards knowledge relationships, the study shows that the national level is the most important space for sourcing both market and technology-related knowledge, followed by the international and the regional levels. For both kinds of knowledge, customers are the most relevant knowledge sources. Furthermore, local and national universities are important providers of technological knowledge.

The agro-technical sector of South Ostrobothnia, in contrast, is situated in a rural and organizational ‘thin’ region’, characterized by a strong agricultural tradition, a relatively low per capita income and outmigration due to lack of educational facilities. Only a poly-technical school and branches of external universities are present. Consequently, the level of R&D in the region is low. The region is specialized in the food industry, but there is also the agro-technical sector that combines competencies in machinery and ICT for uses in agriculture, forestry and the food industry. Most of the firms are small but there are also some larger branches of Finnish firms. Due to the ‘thin’ RIS, fairs are an important channel for acquiring market and technological knowledge. Furthermore, companies draw innovation-relevant knowledge from national customers, suppliers and universities and from international competitors. Due to the weakness of the region and the strengths of the Finnish innovation system in both machinery and information technology (IT), sourcing of knowledge from partners located in other parts of Finland clearly dominates. The two Finnish case studies thus point to strong regional differences in patterns of knowledge acquisition, reflecting the qualities of the respective RIS and the diverging degrees of knowledge availability within the region.

7.3.3 Knowledge Sourcing in Symbolic Sectors: New Media in Vienna, Helsinki and Malmö

The new media sector in Vienna emerged in the mid 1990s at the interface of existing creative industries (Trippel et al., 2013) and the software/IT sector (Trippel et al., 2009). It relies not just on symbolic but also on synthetic (IT) knowledge. The cluster is populated
by many small and micro-firms as well as by freelancers who frequently cooperate in project-based temporary networks (Sinozic and Tödtling, 2015). The mobility of creative and qualified labour is one of the most important knowledge carriers in the Viennese new media cluster. Companies recruit both from the region and from the rest of Austria, and more recently also internationally. Being an attractive city for living, Vienna is able to attract talent from abroad. Relations to other cluster firms as well as the variety of networks within Vienna and Austria also matter for innovation. More recently, these knowledge links have been extended to the international scale, due to relations with foreign clients and suppliers, and to the use of internet-based platforms and communities.

The Helsinki metropolitan area plays a dominating role in the Finnish innovation system since it is the hub of knowledge organizations, R&D centres, universities and schools. Its digital content industry cuts across three different branches, that is, ICT, creative industries and business services, covering ‘all production and design of products and services, that are in digital form’ (Sotarauta et al., 2011, p. 1311). There are numerous very small companies operating in this sector. They innovate mostly by way of incremental service innovations, relying on a complex pattern of knowledge sourcing activities. Recruitment of highly skilled experts at the local level (universities) and the national level (firms in the same sector) plays a key role. Furthermore, market knowledge sourced from local customers and competitors is essential. Technological knowledge is acquired from customers, other firms operating in the same sector and suppliers at local and international levels. Customers are used for testing new services and products in different user communities. Relevant ‘digital knowledge’ is drawn from the internet via virtual communities, websites and social media.

The core of the Southern Swedish moving media industry can be found in Malmö, a former industrialized city that specialized in traditional sectors such as shipbuilding. Malmö has undergone a major restructuring process, turning towards new industries. New media is one of the prime examples in this regard. The rise of the sector was supported by the establishment of a new university college with a focus on fields related to media and design. It has provided the necessary skills and qualifications for the emergence of new media. Policy initiatives promoting start-ups and regional networking also contributed in essential ways to the sector’s development (Martin and Moodysson, 2011; Martin et al., 2014). Overall, the regional context for symbolic industries such as new media has improved substantially. The mostly young and small companies source knowledge mainly through monitoring of markets, technologies and competitors, recruitment of highly skilled labour and cooperation. Non-local knowledge is accessed by participating in fairs and internet searches. Highly skilled labour is mostly drawn from the same industry, with the region being more important than national and international sources. Cooperation with suppliers and customers is also an essential mechanism for acquiring knowledge. More than half of all cooperation occurs within the wider Scania region, reflecting the context-dependent character of the new media sector. The case demonstrates that new symbolic industries can develop in a region with originally adverse preconditions and weak knowledge bases provided that a policy-supported transformation of the regional context takes place.
7.4 DISCUSSION AND COMPARISON OF CASES

The two biotechnology cases, Vienna (Austria) and Aachen (Germany), show that companies working from a predominantly analytical knowledge base rely strongly on universities and research organizations as knowledge sources. However, they also use sources of synthetic knowledge such as hospitals, specialized services, suppliers and customers for testing, (re-) designing or commercializing new discoveries and inventions. Knowledge combination, thus, is relevant in both cases. The spatial pattern of knowledge sources, however, differs between Vienna and Aachen. In Vienna the regional level plays a more important role, reflecting the much larger size of the Viennese biotechnology sector and better knowledge availability within the city region. As a consequence, we find, for Vienna, a local-global pattern of knowledge sourcing and, for Aachen, a strong reliance on knowledge drawn from the larger province of North-Rhine Westphalia and the rest of Germany.

For the ICT sector in Vienna, Upper Austria and Salzburg, combinations of knowledge bases also matter. In all three regions there is a strong synthetic component, in particular, in the software subsector. In Vienna, analytic knowledge seems to play a larger role and as a consequence universities and research organizations within the region (which reflect high levels of knowledge availability) and beyond are among the key knowledge sources. Salzburg’s ICT companies are located in a rather weak RIS, leading to the strong external orientation of firms’ innovation processes. They draw knowledge mainly from suppliers and customers at international and national scales and they rely to a larger extent on contract-based relations. The two Finnish machinery clusters located in the old, but transformed, region of Tampere and the ‘thin’ and rural region of Southern Ostrobothnia complement our findings on the synthetic knowledge base. Due to the fact that Tampere’s RIS has competencies in both machinery and ICT, the heavy machinery industry had good preconditions for adding ‘intelligence’ (for example, IT-based control systems) to mechanical systems. Consequently, we find many links to local universities and research organizations besides links to national ones. The agro-technology companies in the ‘thin’ RIS of South Ostrobothnia have gone the same route, combining mechanical and IT knowledge in new products mainly for the Finnish market. However, they face greater challenges in this regard. As a consequence, and similar to ICT firms in Salzburg, they use other sources and channels for acquiring market and technological knowledge, such as fairs, Finnish and international customers and suppliers, and competitors.

New media, a prime example of a symbolic sector, is more dependent on knowledge from specific cultural and social contexts and shows a strong embeddedness in the region. Since new media is at the interface between creative industries and IT, knowledge combinations are eminently important. In all three investigated cases, companies rely on recruitment of qualified personnel, cooperation and knowledge spillovers as mechanisms of knowledge acquisition. Companies in the metropolitan regions of Vienna and Helsinki rely both on regional and national labour markets for recruiting highly skilled people. Malmö, as a former industrial region, was expected to be at a disadvantage in this regard. However, firms benefited from the establishment of a new university and were also able to draw talent from the wider Scania region. In the Malmö case the region is also an important space for other types of knowledge sourcing. For Vienna we find a
shift from regional and national to multi-scalar networks, and in Helsinki a local-global pattern that is strongly supported and driven by the use of the internet and virtual communities and platforms.

7.5 CONCLUSIONS

Sectoral and regional contexts matter strongly for knowledge sourcing and innovation. Companies require different kinds of knowledge depending on their predominant knowledge base and they face different challenges sourcing and acquiring such knowledge depending on their location. Also, the potential to get access to and combine different knowledge bases varies between metropolitan, specialized industrial and organizationally ‘thin’ contexts. One might thus expect lack of radical innovation and diversification in specialized industrial and peripheral regions (see also Isaksen and Trippl, 2014a). The empirical cases discussed in this chapter, however, show that there are opportunities to change the fate of less favourable regions. Policy actors, for instance, seem to have certain possibilities to support the emergence of new development paths as the cases of Upper Austria, Tampere and Malmö have shown. Also, firms have the possibility of overcoming adverse settings by engaging in knowledge exchange with external firms and organizations (see the cases of ICT in Salzburg and agro-technology in South Ostrobothnia). This requires, however, certain in-house R&D and innovation capabilities in order to identify and acquire external knowledge.

The cases discussed in this chapter also suggest that good policy and governance may help alter unfavourable conditions for innovation and may support the rise of new sectors. In the case of biotechnology in Aachen, we observe that the national policy initiative ‘Bioregio’ had such an effect. The emergence of new industrial activities is also observed for Malmö (moving media) and Tampere (IT and intelligent machinery). Specific policy actions have changed the conditions for knowledge sourcing and innovation in these regions. The knowledge bases were broadened and diversified and new industries were able to develop. But this development has also altered the potential for existing industries to source new knowledge and to combine knowledge bases. The evidence shows that sectors based on synthetic knowledge can benefit from both an expansion of analytical knowledge (new research organizations and firms) as well as symbolic knowledge (for example, in the fields of design, marketing, advertising and so on). Similarly, symbolic sectors such as creative industries and new media benefit from strength in the ICT sector. Finally, in line with recent work (Isaksen and Trippl, 2014a, 2014b), our findings suggest that specialized and organizationally thin regions are more reliant on policy support for combining knowledge bases than diversified metropolitan areas.

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8.1 INTRODUCTION

Innovation policy is partly based on theories of regional clusters and regional innovation systems. Both theories emphasize that co-location of firms and other organizations stimulates companies’ innovation capability and activity. Regional clusters can be defined as companies located in the same region, often a labour market area, and that are linked in different ways (Porter, 1998). Companies can be linked through customer-supplier relationships, through firms using and contributing to the development of common input factors, such as an experienced labour force or specialized suppliers, and through knowledge flowing between firms in different ways, including when employees change workplace within a regional labour market. Regional innovation systems also imply cooperation between companies and knowledge organizations, such as universities, colleges, research and development (R&D) institutions and technology centres (Asheim and Isaksen, 2002). The flow of knowledge between companies and research organizations is crucial to the functioning of regional innovation systems and is stimulated by formal and informal institutions. Formal institutions consist primarily of regulations, rules and policy measures (Edquist, 2005). Informal institutions are routines, habits and norms, often referred to as unwritten rules of the game.

An important explanation for why regional clusters and innovation systems can stimulate companies’ innovation activity is tacit knowledge. Tacit knowledge is knowledge that is difficult to codify, for example, by being written down in a manual. This type of knowledge is best transferred when experienced staff demonstrate, guide and direct newcomers in different tasks (Nonaka et al., 2001). Thus, tacit knowledge cannot easily be transferred over geographic distances (Asheim and Gertler, 2005). Innovation processes that are based on tacit knowledge consequently occur most easily when cooperation partners are in close geographical proximity. Key factors in innovation activity, predominantly specialized labour, are not everywhere and are most available in particular places because labour markets are largely regional.

Theories on regional clusters and regional innovation systems have inspired the design of industrial and innovation policy. For example, key policy tools (or at least instruments that have received considerable attention) in the Norwegian policy support system are based on the reasoning behind theories on regional clusters and innovation systems. Such tools are good examples of researchers’ influence on orientation and priorities in a support system and in the formulation of tangible instruments. The original principles stem from ideas and 1990s publications by researchers such as Michael Porter, Phil Cooke and Bengt-Ake Lundvall. They and others initiated concepts that were tested and partially transformed into specific instruments. After the initial period of development of
new cluster and system tools, these (at least in the Norwegian case) increasingly have ‘lived a life of their own’ and have been less affected by the academic literature. However, several consultancies have emerged that have specialized in evaluations of this type (and other types) of industry and innovation policy instruments.

Research-based knowledge has thus been fundamental to the initiation, design and further modification of cluster and innovation system instruments in areas including Norway. More simply, it can be said that researchers were central to ‘the radical phase’, with the design and implementation of the first tools of this kind. Consultants have, however, been more central to ‘the incremental phase’ that consists of evaluating tools to make them more effective and targeted.

8.2 THE IMPORTANCE OF REGIONAL CONDITIONS

An important reason for the use of tools inspired by the theories of regional clusters and innovation systems is the belief that geographical agglomeration of firms and regional cooperation in innovation activity stimulates firms’ innovation and value creation. Asheim et al. (2011, p. 894) argue that the literature ‘has stressed the importance of regions as key drivers of innovation’.

Other authors argue, however, that geographical proximity has little bearing on companies’ innovation capability. An important development is that many companies are becoming increasingly integrated into global value chains and knowledge networks (Malecki, 2010). When products, services and innovation activities are more complex, companies must collect knowledge from partners and knowledge providers in different parts of the world. Some empirical studies also show that companies often have most of their knowledge links outside the region in which they are located (Malmberg and Power, 2006). Based on data from companies in the five largest Norwegian city regions, Fitjar and Rodríguez-Pose (2011) claim that firms with several types of international partner are most innovative. These authors thus downplay the significance of regional conditions for company innovation activity: ‘the transfer mechanisms of knowledge and innovation within close geographical proximity are either broken or less prominent than previously thought’ (Fitjar and Rodríguez-Pose, 2011, p. 1264).

Such studies provide a basis for questioning the importance placed on regional clusters and innovation systems as sources of inspiration for instruments that aim to strengthen the innovation capability of firms and regional industries. It must, however, be mentioned that researchers have long pointed out that regional clusters and innovation systems are open, in the sense that collaboration and knowledge flow take place beyond regional borders (for example, Asheim and Isaksen, 2002). Consequently, there is no basis in the research literature to maintain that cluster tools should only contribute to increased cooperation between regional actors. The literature argues, however, that the scope and importance of regional cooperation and regional knowledge flow in innovation processes vary between different types of regional clusters and innovation systems. The importance of regional cooperation also varies depending on which type of knowledge is central to firms’ innovation activity (see discussion of knowledge bases below) (Martin, 2012). However, studies also show that measures to strengthen firms’ and industries’ innovation ability are quite rarely adapted to the variety of situations in different types of
firms, industries and regions (Martin et al., 2011). This chapter examines the importance of regional cooperation versus cooperation outside regional boundaries for innovation activity in different types of companies – and thus in what contexts typical cluster policy tools are most and least relevant. The chapter thus contributes to understanding how cluster tools, and innovation policies more generally, can be adapted to different regional conditions.

Few studies have looked at the relationship between companies’ knowledge bases and the geography of companies’ innovation cooperation. Most studies have been theoretically informed case studies of specific industries and regions (for example, Asheim and Coenen, 2005; Martin, 2012). This chapter analyses the results of a nationwide survey in Norway. Based on this survey, we demonstrate how the knowledge base approach can be employed to understand firms’ pattern of innovation cooperation (see also Aslesen and Freel, 2012).

The questions discussed in the chapter are:

- To what extent do firms’ knowledge bases affect the sources and geography of innovation cooperation?
- Based on the answer to this question: do (some types of) cluster initiatives over-emphasize intra-regional cooperation?

### 8.3 KNOWLEDGE BASES AND LOCALIZATION OF PARTNERS FOR INNOVATION COOPERATION

To answer these questions we first have to clarify what is meant by knowledge bases and different types of knowledge flow and understand why companies with different knowledge bases can have completely different requirements from cooperation partners during innovation processes. Interest in studying innovation cooperation is based on a broad approach to and understanding of the concept of innovation (for example, Fagerberg, 2005). The interest relates to understanding what the important input factors in the innovation processes are, how they are implemented and what results emerge.

Focusing on input factors, the broad approach emphasizes that research-based knowledge is only one of the input factors of innovation activity and for many companies it is far from the most central. Important input factors include experience and expertise on how a product or service can be produced efficiently, how to find good suppliers and how to approach a market.

When it comes to the innovation process, the importance of building up unique expertise within companies is given prominence, but supplementary knowledge must also be obtained from external sources. Such knowledge exchange can take different forms (Tödtling et al., 2006; Aslesen and Isaksen, 2007). It can be dynamic as partners work together and learn from each other. Examples include joint development projects between firms and R&D institutes and long-term customer-supplier relationships where customers involve strategic suppliers in innovation projects. The two conditions of internal and external sources are interrelated; companies need to build up internal expertise, often referred to as absorptive capacity (Cohen and Levinthal, 1990), to be able to find, bring in and process relevant external knowledge. The broad approach understands
innovation processes as interactive and socially embedded. They are interactive because of the importance of cooperation between different actors, as partners learn from each other. Innovation processes are socially embedded because cooperation on innovation often requires trust between partners. Trust is stimulated when there is social and institutional proximity between the actors (Boschma, 2005), which means that partners have developed familiarity with each other and share common norms of how cooperation will take place. However, knowledge can also spread in other ways, such as buying technology from other organizations or through observation or labour recruitment.

The broad approach also understands innovation as extending beyond completely new products and services. Innovation can also be a new way of producing products and services, a new way of organizing and leading innovation activity or new marketing methods. The approach highlights that the sum of gradual improvements in products and ways of working may have greater influence and be economically more important than the development of entirely new (radical) innovations.

8.4 KNOWLEDGE BASES AND THEIR GEOGRAPHY

The broad approach to innovation means that studies on how innovation occurs and what affects innovation processes must encompass far more explanatory factors than corporate R&D activity (Cohen and Levinthal, 1989; Birkinshaw et al., 2002; Laursen and Salter, 2004, 2006; de Jong and Freel, 2009). One way of exploring the complexity of innovation processes is through the use of knowledge bases, making distinctions between three different types of knowledge bases: analytic, synthetic and symbolic (Laestadius, 2000, 2007; Asheim and Gertler, 2005). This division forms the basis of the analysis in this chapter.

The concept of knowledge base refers to the main type of knowledge input that is central to the development of new knowledge and to innovation processes in companies. Companies and industries often use several types of knowledge in their activities. In reviewing the dominant knowledge base of a company or an industry, however, the type of knowledge that is absolutely necessary for carrying out innovation activities in the company or industry is revealed. The essential knowledge for that purpose will vary between firms and industries. The starting point for this chapter is that a company’s ability to use knowledge from other actors depends on the knowledge base that dominates in the firms and industry to which the firms belong. The dominant knowledge base will result in certain patterns of cooperation, both in terms of which actors firms collaborate with and where these actors are located.

Much knowledge cannot easily be exchanged between actors. Knowledge is often the result of a collective, complex and path dependent activity that builds on and contributes to developing a knowledge base. Path dependent means that the knowledge developed in collaboration between actors (such as a company and a research institution) depends on the actors’ existing knowledge and any previous experience of cooperation. This is why knowledge bases have a tendency to vary systematically between different industries (Pavitt, 1984; Dosi, 1988; Antonelli, 2005; Asheim and Gertler, 2005; Tödtling et al., 2006; Tripl et al., 2009).

The typology of knowledge bases distinguishes between analytic, synthetic and
symbolic knowledge (Asheim and Gertler, 2005; Tödtling et al., 2011). Individual knowledge bases include specific combinations of tacit and explicit knowledge. While the knowledge base approach defines ideal types that are not necessarily found in their purest form in reality, tendencies towards one ideal type can still be seen in specific industries. Therefore, it is expected that different industries (which are dominated by different knowledge bases) will be characterized by different types of innovation processes and results (Asheim and Coenen, 2006; Aslesen et al., 2012; Isaksen and Karlsen, 2012). The distinction is not a strict categorization of industries but an analytical tool to capture assumed significant features and dominant knowledge and innovation forms in different industries and agglomerations. In empirical terms, it is reasonable to expect that concrete industries and clusters will often rely on different forms of knowledge and innovation associated with more than one knowledge base.

The analytic knowledge base is found in R&D intensive industries and activities that rely on scientific knowledge and are based on specialized scientific skills. Such knowledge can often easily be made explicit and transferred between actors. The meaning will be relatively similar regardless of context. This type of knowledge is strongly dependent on publicly accessible research knowledge and the firms’ internal R&D activities (Lundvall, 1996; von Krogh and Grand, 2000; Hassink and Plum, 2011). It can be linked to knowledge types such as ‘know what’ and in particular ‘know why’ (Lundvall and Johnson, 1994). In industries characterized by analytic knowledge, networks between firms and knowledge organizations are important (Asheim and Coenen, 2005; Gertler and Wolfe, 2006) and since much of the knowledge can be made explicit it is less sensitive to geographic distance. Thus, industries dominated by analytic knowledge are often integrated into global knowledge flows with which researchers in R&D intensive companies and institutions in various parts of the world cooperate (Moodysson, 2007).

A synthetic knowledge base is largely developed through active use of specific technologies that are created through problem solving in companies. This is most common in traditional industries that rely on practical skills (Autio, 1997; Asheim and Gertler, 2005) and where learning and innovation occur through the application of existing knowledge, applied R&D and new combinations of prevailing competence. R&D activity is often linked to development projects that aim to achieve greater production efficiency and reliability or more user-friendly products (Plum and Hassink, 2011). Knowledge is only partially made explicit and thus tacit knowledge and ‘know-how’ and ‘know-who’ (Lundvall and Johnson, 1994; Lundvall, 1996) are important. Consequently, the social and institutional contexts in and around companies are essential for interactive learning and knowledge development (Dougherty, 2004; Gertler, 2004). The most important external knowledge sources are actors in the value chain, that is, customers and suppliers. This means that innovations are often due to ‘pull’ forces in the market or suppliers’ ‘push’ strategies, which often result in incremental changes in processes or products. Since tacit knowledge is important in the synthetic knowledge base, firms are more dependent on geographical proximity to their partners than analytic firms (that is, firms dominated by an analytic knowledge base) (Audretsch, 1998; Martin, 2012).

The symbolic knowledge base is particularly found in what are termed creative industries, which Garnham (2005, p. 25) describes as ‘the key new growth sector of the economy . . . globally’. Creative industries are characterized by knowledge that is created and transmitted using aesthetic symbols, images, sounds and so on. Scott (2000) refers
to the products of creative industries as objects with high symbolic value in relation to the practical value they have. The innovation process involves highly complex, dynamic processes based on tacit knowledge as well as knowledge of ‘know-how’ and ‘know-who’ (Lundvall and Johnson, 1994; Lundvall, 1996). Learning occurs mainly as ‘learning-by-doing’ and often in temporary project teams consisting of experienced and specialized staff. This means that social relationships and the ability to communicate face to face are crucial. Although products can be developed for a global market, local expertise and conventions, cognitive proximity and common rules for developing, communicating and interpreting knowledge are often important in the innovation process. The need for such ‘soft infrastructure’ makes companies in symbolic industries more dependent on geographical proximity for their knowledge search and cooperation (Power, 2009; Hauge and Hracs, 2010).

8.5 THE GEOGRAPHICAL ELEMENT

Research suggests that globalized companies, with exports and participation in global production and knowledge networks, often perform better than other firms because they frequently have superior innovation activity, greater ability to adjust and change organizational structures and communication channels and a better ability to handle turbulence in the market (Lambooy, 2005; Narula and Zanfei, 2005). When partners and sources of knowledge for innovation are geographically dispersed, companies obtain access to new and complementary knowledge that may stimulate innovation activity (Laursen and Salter, 2006; Kafouros et al., 2012). Global knowledge networks thus help maintain firms’ competitive ability and prevent stagnation or lock-in (the limiting of activities to specific ways of thinking and acting) (Grabher, 1993; Malmberg and Maskell, 2006). Combining external, formal (explicit) knowledge from international partners with separate local, tacit (implicit) knowledge can also lead to improved local learning (Cohendet et al., 1999; Lawson and Lorenz, 1999; Cantwell and Iammarino, 2003), implying interdependency between global and local knowledge development. Much knowledge is, however, bound by context in the sense that it is industry and location specific and tacit by nature. There are therefore limits to the extent to which it can be made explicit (Lam, 1997) and geographically transferable. Companies that largely rely on tacit forms of knowledge will be more geographically bound in their learning and innovation processes than companies that also build on an analytical knowledge base.

The intersection between locally and globally based knowledge will vary between industries. Industries dominated by a symbolic knowledge base are most dependent on local and informal knowledge flows that are often found in abundance in major urban centres (Power, 2003). Analytic-based industries are more dependent on research-based knowledge and formal cooperation with professional organizations, which can also occur across long distances (Moodysson, 2007). Synthetic industries are most dependent on knowledge from actors in their own value chains and therefore have innovation and knowledge exchanges with actors both locally and globally (Wenger, 1999).
8.6 THE DATA

The theoretical reasoning above is tested by empirical analyses of innovation cooperation in a range of Norwegian companies. The analyses are based on data from a web-based survey conducted in the project ‘City regions, knowledge bases and innovation support systems’ (CKI) in 2007, funded by the Research Council of Norway. The survey was sent to a random, stratified sample of 5200 companies (with more than one employee) and resulted in 1302 completed responses. The questionnaire included questions on innovation modes, collaboration, networks and innovation barriers. The sample is fairly representative of knowledge intensive firms in terms of sub-branches, firm sizes and locations. The voluntary self-selection process may have resulted in a somewhat biased sample (compared to a survey where it is obligatory to answer, as in public statistics by Statistics Norway).

The analysed firms’ NACE codes (pan-European classification system that groups organizations according to their business activities) were categorized into different knowledge-based categories in line with those reported in the international literature (Power, 2003, 2007; Asheim and Coenen, 2005; Asheim and Gertler, 2005; Asheim et al., 2007, 2011; Moodysson et al., 2008; Strambach, 2008). Thus, firms in the sample are assigned to the specific knowledge base that corresponds with the firm’s NACE classification. The synthetic industrial knowledge base is broad, including both manufacturing and service NACE codes. ‘Synthetic industries’ are thus split into two groups, based on whether they include synthetic service activities (S) (for example, information and communications technology (ICT) consulting) or synthetic manufacturing activities (M) (for example, mechanical engineering) due to possibly substantial differences in the knowledge and innovation forms and networks in services and manufacturing. What we denote as the analytic knowledge base resembles the oft-used ‘knowledge intensive industries’ category based on indicators of high R&D intensity and employment of more highly educated workers (OECD, 2001). Sample stratification resulted in an overrepresentation of knowledge intensive companies, and thus firms grouped in the analytical knowledge base, in relation to the extent of such firms nationally.

8.7 ACCESS TO INNOVATION KNOWLEDGE

The analysis looks specifically at the extent to which the firms’ knowledge base affects who companies engage with in innovation cooperation and where the cooperation partners are located. Table 8.1 shows the extent of innovation cooperation with various partners in firms that are in industries dominated by different knowledge bases. The table reveals, for example, that 80.2 per cent of firms in industries dominated by an analytic knowledge base collaborate with customers in innovation processes.

The results show that there are differences in the use of collaborators between industries. Companies from all the knowledge bases cooperate, albeit most frequently with customers and suppliers. Firms in analytic industries (that is, those dominated by the analytic knowledge base) cooperate most with universities, (partially) technology centres and suppliers. Much cooperation with suppliers possibly reflects Pavitt’s (1984) classification of industries where firms in research-based industries are considered to rely...
on knowledge from producers of specialized equipment. It seems as if companies within synthetic manufacturing activities (designated ‘Synthetic (M)’ in Table 8.1) and symbolic knowledge-based industries cooperate more with competitors than the other two types of company. When it comes to the extent of cooperation with universities and technology centres, this is quite similar for businesses within synthetic manufacturing activities (M) and analytic industries.

8.8 THE GEOGRAPHY OF INNOVATION COOPERATION

The next point concerns where partners that companies collaborate with in innovation activity are located. Based on the theoretical reasoning above it is assumed that firms in analytic industries find cooperation partners over a greater geographic distance than companies in the other knowledge bases. This should be reflected in terms of global networks for the exchange of knowledge in the analytic firms, as opposed to more local networks for companies in industries where social networks and tacit knowledge are regarded as most important (especially in symbolic industries) and in industries where much knowledge is also an integral part of the technology (synthetic companies).

Table 8.2 shows that innovation partners of companies in the various knowledge bases vary from being local to being located outside the Nordic area. For all types of knowledge base the largest proportion of companies report having most innovation cooperation with international partners. Local innovation partners are especially important for companies that are dominated by a symbolic knowledge base, which also have the lowest proportion of innovation cooperation with international partners. Besides their own region, companies in symbolic industries particularly find their partners in the Oslo region. This underlines the important role that large metropolitan areas have as a location and knowledge node for creative industries. Industries within goods production, which are dominated by the synthetic knowledge base, cooperate mostly with partners outside the Oslo region and in particular with partners in other areas in Norway. This reflects the fact that such
industries are frequently located in smaller towns in Norway, which have clusters within manufacturing.

Companies within analytic industries, followed by firms within synthetic services production, report a comparatively large share of innovation partners in the ‘rest of the world’. The results in Table 8.2 show that the location of innovation partners and the geographical spread of these varies according to firms’ knowledge bases and that the pattern is largely compatible with the theoretical arguments put forward in the literature on knowledge bases. However, the figures also show that firms that fall within industries that are categorized as ‘synthetic services’ are more similar to companies in analytic knowledge bases than would be expected from the theory that considers synthetic industries collectively.

Table 8.3 shows the proportion of firms that report the use of different types of ‘foreign innovation channels’. The analytical companies report most foreign knowledge

<table>
<thead>
<tr>
<th>Knowledge bases/ localization</th>
<th>Own region (municipality + neighbouring municipalities)</th>
<th>The Oslo region</th>
<th>Other major city regions</th>
<th>Rest of Norway</th>
<th>Other Nordic countries</th>
<th>Rest of the world</th>
<th>All regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytic</td>
<td>28.3</td>
<td>16.7</td>
<td>13.6</td>
<td>13.3</td>
<td>10.9</td>
<td>17.3</td>
<td>100</td>
</tr>
<tr>
<td>Synthetic (M)</td>
<td>28.0</td>
<td>15.4</td>
<td>22.1</td>
<td>18.6</td>
<td>6.9</td>
<td>9.0</td>
<td>100</td>
</tr>
<tr>
<td>Synthetic (S)</td>
<td>28.5</td>
<td>22.0</td>
<td>12.9</td>
<td>15.3</td>
<td>8.4</td>
<td>12.9</td>
<td>100</td>
</tr>
<tr>
<td>Symbolic</td>
<td>36.4</td>
<td>30.5</td>
<td>8.5</td>
<td>11.4</td>
<td>5.9</td>
<td>7.3</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>29.4</td>
<td>20.6</td>
<td>14.0</td>
<td>14.8</td>
<td>8.5</td>
<td>12.7</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: N = 429.

channels. They use multiple different channels; they combine formal and informal relationships and particularly emphasize contact along the value chain, which suggests that informal meetings and contacts, as well as formal relationships, stretch across geographical distances. The same pattern of formal and informal contact occurs in contact with research and educational institutions.

For all the knowledge bases, the most important channel for obtaining information and knowledge outside Norway is observation of competitors. Both formal and informal contacts with customers and suppliers across borders are considered relatively important by companies from all knowledge bases. Apart from this, companies with synthetic or symbolic knowledge bases have relatively few external information channels that extend outside Norway, which again shows that these industries have a local or national orientation.

8.9 CONCLUSION

This chapter concentrates on two questions. The first regards the extent to which a company’s knowledge base affects who they collaborate with in their innovation activity and where the cooperation partners are located. Our analysis of the CKI survey shows that, regardless of their knowledge base, companies cooperate with many different types of partners but also that there are differences in the use of certain types of partners. Companies that are classified as having an analytical knowledge base and are dominated by synthetic manufacturing activities (M) have more cooperation with universities, technology centres and suppliers than firms with a symbolic knowledge base.

There are also differences when we consider the geography of innovation cooperation. Companies with an analytical knowledge base work with international partners more often and also obtain knowledge from many different channels, both formal and informal. Companies that are classified within symbolic industries undertake far less international cooperation. These types of companies, however, collaborate mostly with actors in their own region and with partners in the Oslo region, while synthetic firms have most collaboration with partners in other parts of the country. Consequently, the geographical cooperation pattern concurs with Martin’s (2012) work, which is based on a completely different type of empirical data. Our empirical results inform the debate on the geography of innovation in several ways. Firms find innovation partners and knowledge sources locally but also in other parts of their country and abroad. The geography of innovation collaboration, however, varies between companies and one distinguishing factor is firms’ knowledge base. The knowledge base determines much about how companies carry out innovation processes internally and what type of supplementary external knowledge is needed, from what actors, and where these actors tend to be located. In sum, the geography of innovation debate needs to take the characteristics of companies’ innovation activity into account.

The second question in this chapter concerns whether (some types of) cluster initiatives are too preoccupied with stimulating regional cooperation, as innovation collaboration occurs with partners at all geographical levels. Fitjar and Rodrigues-Pose (2011) observe that cooperation with actors outside the region has most effect on companies’ innovation capability. We cannot draw such a conclusion based on our analysis, but it is obvious
that cluster initiatives must have a national and international perspective since industries amass much knowledge from partners outside their own region.

Our analyses show that the development and strengthening of regional clusters and innovation systems should not, by default, concentrate on strengthening regional innovation cooperation: it depends on what type of cluster or regional industrial milieu is involved. Analysis of regional conditions can encompass which knowledge base is central to companies that constitute a cluster. As previously shown, the knowledge base affects the scope of national and international cooperation; in particular, clusters that are dominated by the analytical knowledge base seem to have more to gain through international cooperation than clusters dominated by a symbolic knowledge base.

Although not appropriate in every case, cluster facilitation can be strongly associated with establishing regional, formal cooperation among actors. Key tools include contributing to local network building and implementation of joint projects between local actors. These are relevant tools in many contexts. However, the analysis in this chapter shows that companies collect innovation-relevant information and knowledge through a varied set of other channels such as observation of competitors worldwide and informal contact with suppliers and R&D institutions. Recruitment is also seen as an important source of innovation. Thus, cluster facilitation and cluster projects can also have a role in creating more informal meeting places and attracting skilled and qualified employees to specific regions, as this is seen as especially important for innovation.

We argue in the introduction that researchers are central to ‘the radical phase’ of the design and implementation of regional cluster and innovation system policy tools. There is continued evaluation and development of this type of tool (at least in the Norwegian case). We call this an ‘incremental phase’, with minor improvements. Our analyses point to the need for a new ‘radical phase’ with closer assessment of, for example, to which type of areas, companies and industries cluster tools are relevant and also to consider how cluster tools are implemented, for example, how much emphasis to put on stimulating local versus national and global links.

NOTES

1. The project started out with a categorization of almost the entire private sector of NACE industries (excluding energy/water supply, construction, transport) into four main knowledge bases.
2. We have examined companies in the four different industries (which are dominated by specific knowledge bases) that cooperate in innovation activity, and mapped the proportion of companies that cooperate with different types of partners and the percentage who use various channels to collect information and knowledge.
3. The CKI survey was part of the project: ‘City regions, knowledge bases and innovation support systems’ (CKI), which was funded through the DEMOSREG programme by the Norwegian Research Council.

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Part III Cities, innovation and creativity: introduction

Richard Shearmur, Christophe Carrincazeaux and David Doloreux

Cities have almost always been depicted, and thought of, as quintessentially innovative, as places from which new culture, new mores, new fashion and new technology emerge. Dick Whittington left his sleepy rural home for the glitter and gold of London. Karl Marx contrasted the energy, interactions and ideas generated in cities with dull peasants interacting like potatoes in a sack (that is, passively bumping into each other without generating any energy or new ideas). Jane Jacobs went further, attributing the agrarian revolution to cities – though some archeologists suggest she is stretching evidence to the breaking point (Smith et al., 2014).

Notwithstanding this view of cities, it is evident that much innovation originates in non-urban places. Peter Hall, in his book *Cities in Civilization* (1998), describes how the industrial revolution began in the textile producing rural areas of northern England. Perdue (1994) traces the history of innovation in agrarian societies, and more recently Bombardier invented the Skidoo in rural Quebec (Ricci, 2013). It is therefore not a foregone conclusion that cities are the font of innovation.

However, cities clearly play a key role in innovation. Even if innovation can occur outside cities, innovation can – and does – occur in cities also. Given the weight of cities in terms of population and economic activity, it is of paramount importance to understand how innovation is generated within them. In Chapter 9 Wolfe describes how cities attract creative people and how the intense interactions that spatial concentration enables allow innovation processes to take hold. His approach is in keeping with the idea, popularized by Richard Florida, that a mobile creative elite will tend to settle in some places rather than in others, and that once a critical mass is achieved endogenous processes of innovation occur. Comunian et al., in Chapter 11, examine the career paths of creative individuals, tracing their geographic and occupational mobility between place of study and place of employment. They highlight the dominant role of Britain’s major urban agglomerations – a majority of creative jobs are found there – but also highlight stark salary differences between graduates with technical skills and those with an artistic orientation. In Chapter 10 Komninos takes an altogether different approach, but one that is in keeping with the two other chapters: he describes the technological advances – mainly in transport, communication and monitoring – that characterize smart cities. He argues that these serve to enhance the capacity of cities to support and generate innovation-related interactions and collaborations: there is a virtuous spiral of innovation, with changes in the urban environment (the introduction of smart city technologies) leading to innovations in other sectors and activities across the city.

There is, however, a second dimension of cities’ role in innovation that is only alluded
to in these chapters. Whereas the chapters in this part explore the way in which cities generate and promote creativity and innovation, a complementary approach would be to consider how cities exert power over urban and non-urban innovation processes, a concept discussed by Jacobs (1984). With respect to innovation, we suggest that this power works in two ways. First, innovators (that is, entrepreneurs who have developed and marketed a new product or process) and creative people from outside cities are attracted to cities in order to develop their market or to find opportunities to employ their talent, as described by Wolfe and Comunian et al. Yet, since this is the case, it cannot be argued (as Jacobs also does) that cities themselves generate all the innovation and creativity observed within them: rather, some city-based innovation results from the interaction between entrepreneurs and talent from outside the city and resources and opportunities from within. Whereas Jacobs only considers interactions with other cities, we suggest that this is a restrictive view that is biased towards the urban: interactions with rural and peripheral areas are no less conducive to the generation of new ideas and innovation. For instance, Bombardier eventually left rural Quebec and is now an innovative Montreal firm. Textile mills left rural England and converged – for reasons of labour availability and transport networks – on cities. Many archeologists and urban historians argue that it is innovations in agriculture (such as crop rotation, fertilization, irrigation and so on) that slowly enabled a surplus to be produced – from whence cities emerged as trade, management of the surplus, and other city-type activities developed. None of this is meant to downplay the innovation dynamics that occur within and between cities: rather, it serves to emphasize that innovation and talent developed outside cities are often downplayed, thereby over-stating cities’ (already considerable) role in the innovation process.

The second way that cities exert power over innovation is that cities house innovation gatekeepers. Trend-setters, journalists, cultural industries, major universities, stock markets – which act as arbiters of what is considered innovative and creative – are most often urban. They rarely choose to highlight the latest method for ploughing fields in arid climates, innovative ways in which maple trees are trimmed in order to boost syrup production or solutions to providing affordable clean water in remote communities. Rather, there is a tendency for them to focus on fashionable or marketable items – such as high-tech gadgets –, on medical advances important to wealthy consumers and on new industries and technologies with good short-term growth prospects. Likewise, large urban-based companies, such as Google, scour the globe for innovations, buying up those that are likely to succeed (Livi and Jeannerat, 2015). In this way cities act as promoters and amplifiers of innovation – a role that should be distinguished from their role as generators of innovation (which, unlike promotion and amplification, is not unique to cities).

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9. Innovation and creativity in city-regions

David A. Wolfe*

9.1 INTRODUCTION

The rapid pace of innovation that has characterized the process of economic growth and development over the past three decades has raised fundamental questions about the geographical basis of innovation. Although the process of globalization has led to numerous predictions of the ‘death of distance’, growing evidence suggests that the contemporary global economy makes cities more – not less – important as sites of production, distribution and innovation (Morgan, 2004). In this period, recognition has grown that even the most global of economic activities remain fundamentally rooted in city-regions as critical sites for organizing economic activity. Although these processes are strongly shaped by national institutions and global knowledge flows, innovation and creativity overwhelmingly occur in the geographic context of city-regions, which are consequently critical sites for determining economic performance (Gertler, 2001). Many aspects of the trend towards globalization make cities more, not less, important as principal sites for innovation, creativity and the production of knowledge-intensive goods and services. In a paradoxical fashion, the global revolution in transportation and communications technologies has accentuated the concentration of ideas, innovation and economic growth in city-regions.

As the world economy becomes more globalized, the pressure increases for city-regions to create distinct advantages across a diverse range of sectors and industries. The introduction of new ideas in knowledge-intensive production and services is the source of economic growth in the industrial countries. The social nature of the innovation process means that city-regions provide the locale in which the transmission and diffusion of knowledge necessary for innovation occurs. As a result, knowledge transfer between highly skilled people happens more easily in cities. But as Edward Glaeser perceptively notes, ‘(t)he urban ability to create collaborative brilliance isn’t new. For centuries, innovations have spread from person to person across crowded city streets’ (Glaeser, 2011, p. 8; see also Hall, 1998). The dense concentration of economic actors in cities offers multiple opportunities for contact, interaction and the exchange of ideas among highly skilled people. Thus, many of the key foundations of economic success in a globalizing, knowledge-based economy are the social qualities and properties of urban places.

Despite this recognition of the importance of city-regions as the loci of knowledge creation and innovation, a number of critical questions remain about how these processes occur within the urban economy. A second question concerns the relative advantages or disadvantages associated with city size or urban agglomeration. There is widespread agreement that the largest city-regions enjoy certain advantages as centres of innovation and creativity, but they are also subject to greater costs that result from rising land prices and the congestion associated with larger size. Recent surveys of the literature on this question suggest that the doubling of city size can produce a noticeable increase in
Innovation and creativity in city-regions

Productivity across a wide range of different city sizes. At the same time, however, the advantages derived from their more diversified economies, strong research institutions and a deeper talent pool may be offset by negative consequences of urban agglomeration linked to rising land costs and the increased costs associated with urban congestion (OECD, 2006). However, the critical issue here concerns the specific way in which these contradictory economic forces making for urban concentration and dispersion play out across different economic sectors in specific city-regions (Venables, 2006).

There is less agreement on the prospects for mid-sized and small cities. Small and medium-sized cities often operate from a more specialized industrial base concentrated in a narrower range of traditional economic sectors. That offers some advantages, but the future of these cities is closely tied to the specific industries in which they are specialized. The industrial structure of such cities increases the risk that they will be locked into declining sectors or obsolete technologies that may be supplanted by newer ones. However, the speed or flexibility with which their economies can shift from declining sectors to emerging ones may have a disproportionate effect on their economic future. The ability of city-regions of all sizes to adapt to, and absorb, rapid changes in technology, and the competitiveness of their industrial mix, are critical to their economic future.

9.2 INDUSTRIAL EVOLUTION AND THE LIFE CYCLE OF CITY-REGIONS

One of the defining features of contemporary economies is the central role of knowledge and learning in creating economic value and determining competitive success. The critical issue is how the socially embedded nature of the innovation process affects economic growth and development in an urban setting. A number of theories have been advanced to explain the relative pace of industrial growth and decline in city-regions. Traditional explanations of the factors that affect the economic performance of city-regions have been framed in terms of the origins and growth of urban centres; the relationship between the concentration of firms in an urban economy and the growth of local labour markets; the relative degree of specialization or diversity that characterizes the economic structure of individual cities; and the relative importance of lifestyle amenities and the quality of place in increasing the attractiveness of particular cities (Wolfe and Bramwell, 2008). Recent research suggests that these issues need to be considered within the context of a broader set of changes that influence the economic performance of city-regions. The additional factors include the relative size of the individual city, the city’s point of insertion into an evolving global hierarchy of urban centres, and the evolution of the city’s industrial structure towards the growth of higher-level business services associated with a more knowledge-intensive economy.

Conventional theories of urban economic growth emphasize the historical decisions made by firms regarding where to locate. These decisions were often influenced by physical factors, such as the practical necessity of locating near traditional modes of transportation like rivers, coastal harbours or railway lines, or the advantage of operating near rich endowments of natural resources. As transportation systems improved in the post-war period, especially with the introduction of inter-city highway networks in the 1950s and 1960s and the deregulation of airline travel in the 1970s, and as trading relations were
increasingly liberalized on both a continental and global basis, the relative weight of these historical factors on urban location was reduced. Some researchers point to the impact that the mobility of highly skilled and educated workers has on the growth of specific locations, while others focus on pull exerted by existing concentrations of industry. At the heart of this debate is a question about how the locational choices of individuals intersect with and reinforce those made by firms to contribute to the growth and dynamism of modern cities: Do people choose to locate where they find the greatest number of job opportunities, or do businesses locate in city-regions with the largest potential labour market (Glaeser and Gottlieb, 2006; Storper and Scott, 2009)?

A related issue concerns the advantages that firms derive from locating in cities with firms in similar or different industries, and which type of structure contributes most to industrial innovation and economic growth. One perspective emphasizes the benefits for urban growth of specialization in similar or closely related industries, while the alternative focuses on the advantages that flow from a diverse and variegated urban environment. Some analysts maintain that the most important dynamics are those generated by the advantages that accrue to firms located in dense clusters of similar and related firms – in other words, dynamics generated by a greater degree of specialization within city-regions. In this perspective, the advantages created by a dense network of suppliers, a deep pool of skilled labour and the knowledge spillovers that occur among geographically concentrated groups of firms in related industries make the most significant contribution to growth. These advantages are associated with a greater degree of specialization in an urban economy; they are derived from forces that lie outside the individual firm, but are embedded in the industrial sector of a particular city.

This research draws upon a perspective dating back to the late nineteenth century, which suggests that once a region or city establishes itself in a particular set of production activities, its chances for continued growth tend to be high. Paul Krugman, building on the work of Alfred Marshall in the early twentieth century, argues that three types of benefits are created for firms located in the same city-region that specialize in similar technologies or production techniques. The first is the deep pool of specialized labour created by the concentration of firms within similar industries, which makes it easier to hire people with the specialized skills the firms require and attracts more workers to the city-region because of the resulting employment opportunities. The second benefit is the fact that a local concentration of firms in the same industry can support a larger number of specialized providers of intermediate inputs or services, thus enabling firms to concentrate on their areas of competence through the specialized division of labour in the local economy. Finally, knowledge is transferred more easily among firms located close to each other in a city-region than it is over longer distances. The transfer of knowledge between firms in the same industrial sector in the same city-region occurs through the mobility of specialized labour among them, through the tendency of serial entrepreneurs to establish a succession of firms in the same city and through the ‘learning-by-observing’ effects of densely concentrated industries (Krugman, 1991).

Conversely, others emphasize the innovation potential that arises when new forms of knowledge circulate among a wide range of sectors within a city – in other words, from the dynamics associated with greater diversity in the economic structure of a city-region. This perspective, associated with the work of Jane Jacobs, suggests that new and innovative ideas derive from the cross-fertilization that occurs across different industrial sectors.
Therefore, city-regions that are endowed with a diverse range of industries, rather than those that are specialized in a smaller number of industrial sectors, enjoy the conditions most conducive to innovation and growth. Innovative ideas are derived by applying knowledge that may be considered standard in one sector to help solve problems or develop new products in another sector of the local economy. Jacobs also suggested that competition among alternative sets of ideas embodied in a diverse set of economic actors is more conducive to generating new knowledge than the local monopoly over ideas that exists in a more specialized urban economy (Jacobs, 1969). The possibility of cross-fertilization arising from an economic structure with greater variety enhances the potential for the generation of new ideas and innovation within the local economy. The question of whether industrial specialization or diversity has the greater potential for innovation and growth has critical implications for how city-regions adapt in a knowledge-based and globalizing economy.

These competing views on the sources of urban economic growth have stimulated a substantial body of academic research that provides some evidence to support both perspectives: that the presence of both specialized and diversified urban economies contributes to the overall performance of city-regions, but the two factors may act in different ways in cities of different size. A recent survey suggests a possible explanation for the apparently contradictory results. Part of the confusion may arise from the omission of time as a factor in determining whether the economic benefits associated with specialization or diversity exert a more important influence on the economic performance of firms in city-regions. In effect, ‘the role of externalities varies according to the maturity of the industry. Jacobs externalities predominate in the early stages of the industry life cycle, whereas Marshall externalities enter at a later point, and in the end, specialization will in fact hinder economic growth’ (Beaudry and Schiffauerova, 2009, p. 334).

This conclusion is consistent with other findings that the introduction of an industry life cycle perspective, as well as a better appreciation of the relationship between city size and diversity or specialization, help explain the relative contribution made by industrial specialization and diversification to urban economic growth. The economic benefits associated with a more diversified local economy play different roles in the innovation process at various stages in the maturity of the industry, while differences in population also affect cities’ ability to create and diffuse new knowledge. Duranton and Puga (2000) suggest that firms often develop new products in the diversified, creative environment found in larger urban centres, but as the technology and industry mature, there is a strong incentive for them to relocate to more specialized cities in the mass production phase of the industry’s life cycle in order to exploit urban cost advantages. Larger city-regions tend to be more diversified and knowledge intensive than medium-sized and small cities. Where large cities have multiple specializations, medium-sized cities have significantly fewer. Related findings reveal that levels of innovative activity are also strongly linked to city size, with research and development (R&D), patenting and major product innovations much more concentrated in large urban areas (Audretsch, 2002).

This insight is reinforced by an argument linking industrial activity, economic fortunes and city size. Large cities with a diversified industrial base are more insulated from the impacts of economic change, while smaller ones with a narrower industrial base are more subject to a life cycle of growth and decline (Brezis and Krugman, 1997). While a greater degree of specialization does stimulate the growth of some medium-sized cities, the
outlook for those cities is linked to the economic prospects of the specific sectors in which they are specialized. Once the sectors lose their competitive edge, the cities may lack the knowledge base or the quality of place to diversify their local economy into newer and expanding industries. They are often confronted with the challenge of regenerating their local basis for economic development without the institutional capacity that can furnish a fresh supply of ideas and new sources of growth.

This suggests that ultimately the source of innovation and economic growth for a city-region rests not just on the degree of specialization or diversification in its industrial structure but more importantly on the resilience of the city-region in mobilizing its economic assets in the pursuit of a new basis for growth (Christopherson et al., 2010). The key issue concerns the ability of firms, industries and institutions in a specific city or region to adapt their existing knowledge base and localized capabilities to the generation and exploitation of new commercially valuable sources of knowledge. ‘New paths do not emerge in a vacuum, but always in the contexts of existing structures and paths of technology, industry and institutional arrangements’ (Martin and Simmie, 2008, p. 186). Resilient regions tend to be those that prove adept at making the transition out of declining industries, while they are simultaneously able to exploit the local knowledge infrastructure to cultivate new, potential growth fields. However, future patterns of development are strongly influenced by the existing industrial structure, as well as the broader set of institutions that have supported that structure. Those sectors in which the city-region has historically been specialized will constrain its future ability to grow, or create opportunities for new sectors to emerge. The basis on which those sectors can emerge will be influenced in turn by the capacity of firms and institutions within the region to develop and exploit new sources of knowledge and their existing knowledge infrastructure, as well as the talents and skills of the workforce (Wolfe, 2010).

Variations in the ability of cities to create and diffuse new knowledge appear to be important for the cities’ long-term growth prospects, as well as their ability to adjust to changing economic conditions. Indeed, as John Montgomery argues, ‘(a)t the end of the day, there are only a handful of means by which city and urban regional economies can grow. One is the introduction of new production processes and services to create new work and new divisions of labour . . . More important than this even is the extension of new technologies to create new products and therefore economic sectors’ (Montgomery, 2007, p. 29). This introduces a distinctly Schumpeterian dimension into the analysis of urban economics that underlines the impact of the capacity to innovate. New economy sectors are sustained by the continuous pace of innovation and learning needed to keep abreast of the rapidly moving knowledge frontier in their industries.

This need for continuous innovation extends well beyond the manufacturing sector of the economy. In an innovative economy where the knowledge frontier is moving rapidly, dynamic cities are those able to draw on their local knowledge assets and research infrastructure to reinvent themselves by moving from one field of specialization to another. In this transition, existing industries may provide the essential building blocks for the emergence of a new innovative industry because the skills and talents that have accumulated over time may furnish critical inputs needed by the emerging industry. The ability of individual city-regions to marshal their local knowledge assets and develop local concentrations of expertise in emerging technology areas may be a good indicator of their prospects for resurgence and growth. As two experts put it, ‘[T]he important question
may not be specialization versus diversity but whether a city has specialized in the right thing at the right time' (Storper and Manville, 2006, p. 1250).

The capacity of individual cities to make the transition to more information-intensive forms of industrial activity depends not just on the functioning of autonomous market-based processes; it is also affected by their social and political structures. The emergence of new technologies and industrial sectors is often associated with a corresponding set of changes in the industrial geography of cities and regions. It is not surprising that the new information technologies or biotechnologies tend to be associated with names such as Silicon Valley, San Diego, Austin, Texas or Research Triangle Park in the USA or Helsinki and Bangalore in Europe and Asia – places that scarcely registered on the industrial map prior to 1970. These cities, which were among the most dynamic of the late twentieth century, were home to many of the technologies that anchor the expanding knowledge economy (Montgomery, 2007, p. 22).

This transition poses significant economic challenges for older, established metropolitan areas in the USA, Europe and Canada that dominated the previous industrial era. These cities were once the pinnacles of economic growth and prosperity to which other urban regions aspired: ‘[T]he Silicon Valleys of the Second Industrial Revolution had names like Akron, Detroit, Pittsburgh, and Rochester’ (Safford, 2004, p. 16; see also Moretti, 2012, p. 20). While some older industrial cities in the USA have experienced a recent economic resurgence due to their ability to shift to knowledge-intensive activities, many have not. Cities and regions that remain locked into traditional specializations in mature manufacturing and are unable to capitalize on existing knowledge assets or to mobilize their local endowments of human capital face greater challenges in effecting this transition (Glaeser, 2011; Moretti, 2012).

9.3 DIVERSITY AND THE EMERGENCE OF AN INTERNATIONAL HIERARCHY OF CITIES

The relation between the size of a city-region and its economic prospects is determined not just by its place within the national economy but also its relative standing within a hierarchy of global or world cities. In a seminal paper, Peter Hall identified the importance of urban size and the degree of specialization as important signifiers for an emerging international hierarchy of urban centres (Hall, 1966). Around the same time, the Canadian economist Stephen Hymer suggested that the growing predominance of multinational corporations in the global economy was likely to increase the stratification of world cities, creating a new global division of labour between geographic areas corresponding to the vertical one within the firm. This would result in a concentration of those occupations with responsibility for corporate decision-making within a few of the world’s major cities – such as New York, London, Paris, Frankfurt and Tokyo – supported by a larger number of regional hubs. As a consequence, the structure of income and consumption in those major cities would match the distribution of status and authority, with the citizens of these global capitals enjoying the best jobs and the highest rates of remuneration (Hymer, 1972).

In the decades since, this provocative insight has been expanded upon in the growing literature on the stature and importance of ‘world cities’ or ‘global cities’. According
to Saskia Sassen, the fundamental dynamic at work ‘is that the more globalized the economy becomes, the higher the agglomeration of central functions in a relatively few sites . . . the global cities’ (Sassen, 2001, p. 5). The position of these cities in the global hierarchy is determined both by the role they play in coordinating the processes of production and distribution of goods around the world and in providing the specialized services that large, complex firms require to manage a spatially distributed network of offices, factories and distribution centres. Increasingly, these global cities have also become the key sites for innovation in the financial services industry and the development of new financial instruments, two of the most notable features of the global economy since the 1980s. Rather than being randomly distributed around the world, as some enthusiastic supporters of the digital revolution maintained, these high-end financial and information services have in fact become ever more concentrated in the central business districts of a few leading cities that are specialized in the production of producer and financial services. International gateway cities – such as Paris, London, Tokyo, New York and Los Angeles – located at the peak of the urban hierarchy achieve a higher level of economic performance because of their access to large pools of highly specialized and technical workers and the wide range of innovative firms located in the cities (Simmie and Wood, 2002; McCann, 2008).

Below this top tier of truly global cities is a wider range of urban centres with a concentration of diverse knowledge-intensive production and service activities that act as the economic hubs of their respective national economies and serve as the principal nodes linking those economies into the global economy (Simmie, 2003). They play a key role as knowledge hubs – both for their countries and for the wider world – due to their ability to attract exceptional talent, and to capitalize on global and local sources of knowledge, much of which flows through their local companies. Knowledge flows more easily in big urban centres, which are advantaged in their abilities to draw on both local and global sources of knowledge and attract the best ‘talent’, thereby insulating themselves from the consequences of population and industrial change (Florida, 2002; Scott, 2008; Glaeser, 2011).

However, these leading cities are not the only sources of innovation. Regional hubs, such as Montréal, Toronto, Boston and Milan, are also highly competitive and play an important role in the global hierarchy. These national and regional hub cities contain high proportions of elite business and political leaders with the authority to make local investment decisions, which gives these urban areas a greater degree of autonomy. With their large populations, these cities also enjoy the benefits of economic agglomeration due to the concentration of a wide range of knowledgeable collaborators from different disciplines who can contribute to the innovation process (Simmie, 2002). Medium-sized cities that are specialized in a narrower range of industrial activities can serve as hubs for their regional economies, but they have more limited access to global knowledge flows and trade. The most dynamic medium-sized cities, which make the most effective use of local institutional research supports (universities) and social networks, are able to specialize successfully in knowledge-intensive industrial activities (Safford, 2004).
9.4 URBAN AGGLOMERATION AND THE CONCENTRATION OF TALENT AND CREATIVITY

Another view of the underlying determinants of urban dynamism and economic growth focuses on the role of talent and creativity. The critical link between innovation, personalized knowledge exchanges and economic growth makes the most important locational asset a dense labour market of highly educated and creative workers – what Cooke calls ‘regional talent pools of global significance’ – with the potential to attract and embed globally mobile investment, and generate innovative growth (Cooke, 2007). This view suggests that the local attributes that attract talented workers are of paramount importance in determining local economic prosperity. Such talent is attracted to and retained by cities, but not just any cities; those that offer rich employment opportunities, a high quality of life, a critical mass of cultural and entertainment activity, and social diversity are said to exert the strongest pull (Glaeser et al., 2006).

A different line of reasoning maintains that the causal link between concentrations of creative and talented and regional economic growth may in fact be reversed; instead of skills driving economic growth, the preference of firms for locating in regions with large, diversified economies may be the primary factor in attracting and retaining large concentrations of creative workers, thus stimulating urban growth and innovation (Storper et al., 2006; Scott, 2007, 2008). ‘Though person-embodied talent remains a critical input into innovation, it needs to be considered in the context of the other factors discussed above, such as city size, industry specialization, local institutional infrastructure, and knowledge flows’ (Wolfe et al., 2008, p. 177).

In addition, the more concentrated the talent, the more innovative the output. One of the key advantages of cities in a globalized economy is that they reduce the cost of knowledge transfer, and act as centres of idea creation and diffusion where talent clusters. There is also a strong correlation between population densities in general, the density of creative workers in particular and metropolitan patenting activity, suggesting that population density is critical for generating knowledge spillovers and innovation (Carlino et al., 2007).

9.4.1 Cities as ‘Schumpeterian Hubs’ of Innovation

While a significant body of research points to the positive correlation between urban concentrations of talent and human capital in urban centres and the prospects for economic growth, some scholars suggest that the high concentrations of human capital may be the result of other positive externalities found in these cities. This perspective maintains that skills-led explanations of economic growth confuse the nature of the relationship between the locational decisions of individual workers – creative or otherwise – and those of firms. These critiques argue that the primary determinant of urban growth is not just the locational preferences of highly skilled and creative workers but the concentration of firms that generate a dense labour market in the first place. Pointing to the fact that economic resurgence has occurred not just in Sunbelt cities but also in ‘old, cold, dense city-regions’ such as Boston, Chicago and New York, Storper and Manville (2006) argue that recent population growth in cities – both older, northern ones and new, southern ones – is linked to shifts in regional economic geography and industrial activity. Workers
are drawn to urban centres where employment opportunities are the greatest, not just to those with lifestyle amenities such as shopping and entertainment, which are ubiquitous and readily available in most cities of a certain size.

Jacobs, Florida and Glaeser are all on to something in claiming that skills and amenities go together, but they may have got their causality reversed. It is the fact that these skilled workers are congregated in certain places that leads to the presence of amenities and, in some cases, makes the places tolerant and bohemian as well (Storper et al., 2006, p. 1254).

The argument that workers are attracted by employment opportunities more than by consumer, lifestyle and social amenities suggests that explanations of urban economic growth need to be more nuanced. A related body of research indicates that human capital levels are becoming more unequally distributed across urban centres, as cities with a higher concentration of innovation-related jobs generate greater employment opportunities in other sectors of the urban economy. Recent research points to the fact that knowledge-related jobs in innovation-based industries have a much higher multiplier effect than jobs in other industries. According to Enrico Moretti, ‘for each new high tech job in a metropolitan area, five additional local jobs are created outside of high tech in the long run’ (2012, p.60). Most economic sectors have a multiplier effect on related employment, but few sectors have as great an effect as high tech with its concentration of innovation-related jobs. The reason for this is that high tech firms tend to co-locate due to advantages created by potential knowledge spillovers and access to a larger labour market. The implication of this is that urban centres with a higher concentration of jobs in these sectors are likely to grow faster than other cities due to the spin-off of related jobs. This trend is reinforcing the bifurcation of cities between larger ones with greater concentrations of innovation-based and knowledge-related jobs and more traditional manufacturing or resource centres that face increased difficulty in maintaining their employment base. In the middle may be few cities that are able to shift their base of economic activity from more traditional resource and manufacturing activities to knowledge-based ones (Moretti, 2012).

The boundary between traditional sectors of the economy is shifting as the impact of innovation is blurring the distinction between traditional manufacturing and service-oriented activity. While many industrial activities still occur in identifiable sectors staffed by industry-specific occupations, many of the knowledge-intensive activities associated with new and emerging sectors of the economy are less easily categorized. Changing patterns of urban development are similarly ambiguous. Allen Scott describes shifts in the nature of economic activity in terms of an emerging ‘cognitive-cultural economy’ where leading-edge economic growth and innovation are driven by ‘technology-intensive manufacturing, diverse services, “fashion-oriented neo-artisanal production,” and cultural products industries’ (Scott, 2007, p. 1466; see also Scott, 2008). The shift to this new form of production is facilitated by the steady adoption of digital technologies for creating more customized goods through a less routinized organization of the production process. In this view, the location choices of the creative class and related concentrations of human capital result from the broader economic transformation to a knowledge-based economy that is underway. The larger forces at work are the outcome of historically conditioned trajectories of urban economic growth, where the supply of, and demand for, labour evolve in a mutually reinforcing fashion.
The interaction between the location decisions of firms and those of highly skilled workers is strongly influenced, though not completely determined, by city size. Scott argues that the transition to a ‘cognitive-cultural economy’ is most pronounced in the major metropolitan centres of the advanced economies, where ‘the internal production spaces of these cities are being remade in the image of the core sectors of the new economy, such as technology-intensive industry, finance and business services, fashion and media ...’ (Scott, 2012, p. 34). Consequently, the presence of the ‘cognitive-cultural economy’ is most apparent in large metropolitan areas or ‘flagship hubs’, such as New York, London, Paris, Amsterdam and Tokyo, where production activities are densely concentrated in firms with global market reach. However, intermediate cities, such as Austin, Texas or Calgary in Canada, have also developed large concentrations of technology-intensive activity and higher end business service. New information technologies permit the simultaneous dispersion and concentration of economic activity, allowing producers in various urban centres to benefit from the local knowledge flows in a specific location, as well as to access global knowledge flows and markets. Virtuous cycles of growth result as the number of producers increases and local growth accelerates, leading to a deepening of localized returns and the intensification of economic benefits.

The emphasis on growth driven by the virtuous interaction of skilled labour and firm preferences characterizes large metropolitan cities as environments where value chains underlying production, and the associated networks of economic actors, can adapt rapidly because of their efficiency at coordinating and managing the processes that are the basis of innovation and growth. In this sense, cities are acting like giant ‘Schumpeterian hubs’ of innovative activity, or ‘switchboards which permit the constant creation and reshaping of the chains linking producers, consumers, and different kinds of indirect players of the economy’ (Veltz, 2004). Signs of this developmental dynamic are evident in large metropolitan areas, both in rapidly growing ‘cognitive-cultural sectors’ and in the formation of ‘intra-urban industrial districts devoted to specialized facets of cognitive-cultural production’, such as high tech and software in the San Francisco Bay area, movies in Hollywood, business and financial services in New York and London and fashion in Paris and Milan (Scott, 2007, p. 1470). These emerging areas of cognitive-cultural production tend to be located in, or close to, the central business district and often take advantage of low-cost space available in abandoned industrial warehouses or factories. The conversion of existing physical spaces associated with the older industrial economy to new uses for the emerging cognitive-cultural economy illustrates the critical way in which the spatial landscape of the inner city is reconfigured in dynamic urban regions (Hutton, 2008, p. 11).

Despite the appeal of a talent-based approach to urban economic growth and development, the uneven distribution of creative occupations and highly skilled labour and the resulting increase in social disparities in some of the most successful city-regions suggest there are inherent limits to this approach to urban growth strategies. The rise of creative cities in North America and Europe is a product of their role as places with the ability to generate a high level of technological innovations and economically useful knowledge. Further confirmation for this insight lies in the fact that scientific and creative occupations tend to cluster together in urban centres (Beckstead et al., 2008).
9.5 THE DYNAMICS OF INNOVATION AND CREATIVITY IN CITIES: FINAL OBSERVATIONS

This chapter has surveyed some of the evidence on the virtues of economic specialization versus diversity for urban economic growth; the emergence of a global hierarchy of cities around the world with ever more differentiated economic roles; the relative importance of greater concentrations of highly skilled and creative workers as attractors for firms and industries; and the relationship between creative occupations and creative industries as drivers of urban economic growth. The evidence discussed above leads to some interesting observations.

First, cities of different sizes play different roles in the broader urban system of both their own national economy and the broader global economy, with respect to specialization and diversification. Larger cities with a more diverse range of industries and more extensive research infrastructure are frequently, though not exclusively, the locations where new ideas leading to new products and industries are developed. As the technologies and their associated production processes evolve, firms often relocate to medium-sized cities with traditional cost advantages. The evidence confirms this pattern has been particularly true in the case of the traditional manufacturing industries that dominated the urban economy of North America and Europe through the post-war period of growth. There is less clear evidence to conclude it will necessarily hold true for the newer industries that have emerged over the past two decades and are still developing.

Second, the spread of a globalized economy has also led to the concentration of higher order financial and business services in larger cities around the world, but a clear division has emerged between those cities that operate on a truly global scale and those that act as national and regional hubs for their hinterland economies. At the same time, there is growing strength in a wide range of industries related to the design of fashion and cultural products, many of which involve digital content. The tendency for these industries to co-locate with the existing concentrations of financial and business services has led some observers to describe this development in terms of the emergence of a new cognitive-cultural economy. While creative and talented workers locate in greater concentrations in cities with strength in financial and creative industries, the exact nature of the causal link between the two remains debated.

Third, there is growing importance of knowledge-based activities, design and the cultural industries to future economic growth, especially in North American cities. While the evidence suggests that large cities have certain advantages in this respect, the successful development of new dynamic regions in the USA and elsewhere, with respect to both the production of new technologies and cultural activities, suggests that it is not a foregone conclusion. However, this tendency does pose serious challenges for small and medium-sized cities that have developed historically as more specialized manufacturing centres.

NOTE

REFERENCES


10.1 INTRODUCTION

The aim of this chapter is to present key aspects of the intelligent city landscape referring to the concept, structure, planning and operation of these socio-technical systems, and contribute to the understanding of intelligent cities as a distinct type of innovation environment and territorial system of innovation characterized by digital proximity and collaboration, global information and technology flows, user-driven innovation and resource optimization.

The era of intelligent cities opened with academic publications on networking and technopolitan development in the early 1990s (Batty, 1990; Gibson et al., 1992; Laterasse, 1992), unfolded with limited experimentations in Web 1.0 technologies and a few publications in the early 2000s, and culminated in a massive explosion of papers and smart city solutions after 2010. Currently, big multinational companies are involved and large-scale initiatives are taken by cities worldwide. This orientation, however, has its roots in the fertile background created by the move of cities and regions to technology and innovation as sources of competitive advantage, productivity growth and sustainable development (Scott, 1988; Pyke et al., 1990; Storper, 1993; Cooke and Morgan, 1997; Simmie, 1997; Keeble et al., 1998, Doloreux and Parto, 2005). Within this tradition, intelligent cities promote the understanding that geographical proximity together with institutions offer the binding agents that enable innovation systems to emerge and operate, and cities and regions to profit from digital technology and innovation to create environments and systems propelling innovation.

The perspective of systemic innovation and territorial systems of innovation is critical to intelligent cities, in the sense that intelligent cities add digital proximity, networking and interaction to the geographical and institutional proximity that sustain innovation systems. If networking and knowledge flows are the founding elements of innovation systems, then intelligent cities offer an additional boost to innovation by the rich information and technology flows they accommodate.

From this perspective, the structure of the chapter is as follows. Section 10.2 is largely a summary review of the literature of publications to be found on Google Scholar over the period 2001–14. Here, the purpose of analysis is to reveal critical aspects of the intelligent cities landscape in terms of components, and the variations of terminology and meaning that we find in this corpus of literature. For many readers the simultaneous use of terms such as ‘smart city’ and ‘intelligent city’ might be a source of confusion, while it should be considered as a sign of wealth in procedures and technologies by which city intelligence is achieved. We explain how the diversity of forms
and terms is inherent to a basic structuring model and its multiple manifestations and
combinatory variants.

In Section 10.3, we look at the formation processes of intelligent cities and at how a
bottom-up emergence of digital applications and solutions goes together with top-down
planning, strategy development and the meticulous design of implementation actions.
Here, we look at well-known case studies, and the analysis is essentially comparative
and typological to reveal the main types of planning and strategy followed. As happens
in physical planning, every city is a unique outcome of planning in the framework of
circumstances and inertia inherited from the past, but this diversity does not impede
profiling ‘ideal types’ that work as widely accepted planning models.

Section 10.4 turns to a fundamental question and raison d’être of intelligent cities:
their operation and impact. Here, the focus is on innovation circuits that start from the
digital space of cities and various kinds of smart environments that amplify decision-
making and the optimization of the urban system. We discuss the knowledge and inno-
vation processes that are built from global and user-driven web solutions for foresight,
technology learning, innovation, funding and marketing. We also look at the knowledge
processes supported by custom and local applications at various smart city software
repositories.

The chapter concludes by an inquiry into the challenges of intelligent cities: what can
be done better in such environments? Which problems can be addressed? What are the
domains that can be optimized or where innovation is expected? How can cities profit
from capabilities offered locally and globally through digital technology, relying more on
training and education than large-scale and expensive technological infrastructure that a
few cities, usually the most affluent, can afford.

10.2 INTELLIGENT/SMART CITIES: A RISING LITERATURE
BUT A FUZZY CONCEPT

The sporadic pioneering publications during the 1990s were followed by a series of pub-
llications during the 2000s that led to the formation of the academic field of intelligent
or smart cities. A survey on Google Scholar publications referring to terms ‘intelligent
city,’ ‘intelligent cities,’ ‘smart city’ and ‘smart cities’ for the period 2001–14 reveals a
total number of 26,383 publications, from 148 papers only in 2001 to 9814 publica-
tions in 2014, and delineates the gradual shaping of this interdisciplinary academic field
(Table 10.1).

The turning point of this exponential growth in publications was the year 2010,
when the total number of publications doubled compared with the previous year; then
the annual growth rate of publications in this field remained very high (Table 10.1,
Figure 10.1). To my knowledge, this coincides with the interest of large companies such
as IBM, Cisco, Accenture, Siemens and others in smart cities, city intelligence and smart
cities as a prospective field for the Internet of Things. It also coincides with the inclu-
sion of smart cities in the European Union research agenda, in programs such as the
Competitiveness and Innovation Program (CIP), the Future Internet Public-Private
Partnership Program (FI-PPP), the European Innovation Partnership on Smart Cities
and Communities, and Horizon 2020. However, this intense publication activity indi-
cates something more than a new academic field of study and research; it also highlights the formation of a new science of urban systems, transcending urban studies, geography and planning, innovation theory, system theory, information and communication technologies (ICTs), sensors and embedded systems, big data and analytics.

The analysis of this corpus of literature reveals many aspects of emerging research, planning, and policy-making, such as core ideas, research orientations, ontology and topics, models, technologies, processes sustaining urban intelligence, success factors, challenges to address, metrics and so on. Aiming to highlight key aspects of this literature, we examine a sub-set of the above corpus, composed of the most cited publications, a relatively small set of papers and books that makes up the lion’s share of citations. Using this smaller corpus, which seems to be more influential in the academic milieu, we attempt to trace the fundamental understandings, concepts, structures and terminologies in the intelligent/smart city literature.

Since the first publications on intelligent cities (Batty, 1990) and smart cities (Gibson et al., 1992), there has been a direct connection between these topics and the innovation literature. On the one hand, digital space offers conditions for creating intelligent cities, introducing disruptive innovations to cities and driving a series of radical changes in the relationship between the population and the urban environment. On the other hand, the same digital space strengthens the mechanisms of innovation at work in cities, complementing and extending the innovation systems that are formed at various urban and regional scales. Intelligent cities are created as a result of innovations in digital technologies and act, simultaneously, as drivers and enablers of innovation.

The evolutionary logic of innovation systems and intelligent cities as a discrete stage of their development is clearly stated in Komninos (2002, 2008). Earlier forms of territorial systems of innovation, such as industrial districts, innovation clusters, innovation poles,
incubators and others, have evolved and were integrated into broader regional innovation systems where institutional cooperation agreements and targeted policies strengthen the systemic relations of geographical proximity. These larger innovation systems were further enriched by the adoption of digital technology and online collaboration, data analytics and various kinds of digital platforms that facilitate innovation. These digital facilities enable other forms of collaborative innovation to emerge, which involve users and lead users (Von Hippel, 2005), Living Labs (Pallot et al., 2011), large-scale digital technology markets, innovation brokering and funding mechanisms such as Innocentive, yet2.com and Kickstarter.

The creation of cities’ digital space also followed an evolutionary process, clearly described by Mitchell (2007). The elements of artificial urban intelligence appeared through a process of technological emergence and integration into larger systems starting with packet switching, Ethernet, Internet and the World Wide Web, wired and wireless communication channels, computer miniaturization, laptops, mobile phones, embedded microprocessors, digital sensors, RFID tags, GPS, embedded smart objects, and large-scale software, business and retail applications, social media and finally the emergence of cognitive hierarchies. The digital intelligence of cities resides in this increasingly effective combination of telecommunications, ubiquitously embedded systems, software and data, offering advanced knowledge and cognitive competence.
Therefore, intelligent cities should be understood as territorial systems of innovation with spatial, institutional and digital proximity. Such cities improve: their management capacity and transition from government to governance (Paskaleva, 2009); productivity gains and higher quality of life (Shapiro, 2006); integration of human, technology and institutional factors (Nam and Pardo, 2011); better urban performance and environmental sustainability. These advantages depend not only on a city’s endowment of hard infrastructure (physical capital) but also on the availability and quality of knowledge communication and social infrastructure (human and social capital) (Caragliu et al., 2011).

Among the many different definitions of the concept, and consistent with the above understanding of intelligent/smart cities as environments enabling innovation, is the definition proposed by Schaffers et al. (2012, emphasis added):

The smart city concept is multi-dimensional. It is a future scenario (what to achieve), even more it is an urban development strategy (how to achieve it). It focuses on how (Internet-related) technologies enhance the lives of citizens. This should not be interpreted as drawing the smart city technology scenario. Rather, the smart city is how citizens are shaping the city in using this technology, and how citizens are enabled to do so. The smart city is about how people are empowered, through using technology, for contributing to urban change and realizing their ambitions. The smart city provides the conditions and resources for change. In this sense, the smart city is an urban laboratory, an urban innovation ecosystem, a living lab, an agent of change. Much less do we see a smart city in terms of a ranking; this ranking is a moment in time, a superficial result of underlying changes, not the mechanism of transformation. The smart city is the engine of transformation, a generator of solutions for wicked problems, it is how the city is behaving smart.

Much more than a set of generally accepted goals of competitiveness, sustainability, inclusion and a vision for the future (Bowerman et al., 2000) intelligent cities or smart cities are agents of change, physical-digital systems of innovation and mechanisms of collaborative intelligence, which can serve every human community in achieving its own objectives and targets. From this point of view, intelligent cities and smart cities denote the same concept of environments enabling innovation through digital technology. The differences in the terms used (intelligent, smart, digital, cyber) lie in the processes they use and the emphasis on technology or human resources in achieving city intelligence. The quest for a real smart city (Hollands, 2008) is always pertinent and the diversity in defining and understanding intelligent or smart cities should be attributed to the variety of enabling environments they offer and to the multiple forms in which they appear.

10.3 FORMATION OF INTELLIGENT CITIES: BOTTOM-UP AND TOP-DOWN TRAJECTORIES

Various sources provide information about cities around the world that have adopted the intelligent city agenda, academic papers list cities implementing smart city solutions and governance (Nam and Pardo, 2011; Komninos et al., 2013; Angelidou, 2014), and there are competitions and awards assessing cities or city districts for achievements in this field, such as the Intelligent Community Forum that has selected 21 smart cities, seven intelligent communities and one top intelligent community every year for 15 successive
years since 1999. There are also a variety of city metrics that highlight performances of cities in smart city indicators (Corntight, 2006; Giffinger, 2007; Dirks et al., 2009), media increasingly cover news about the design, funding and progress of particular intelligent cities (such as PlanIT Valley in Portugal, Saudi Arabia intelligent cities, SmartCity Kochi, Smart Amsterdam, Barcelona Smart City and many others), and some cities have been ‘adopted’ by large organizations such as IBM, the European Commission, the IEEE Standards Association, receiving support and grants for implementing intelligent city solutions. The list of these cases is very long. In fact, every city is becoming intelligent as broadband infrastructure, web applications and smart city solutions are being developed and used by their citizens, organizations and institutions.

This large corpus of cases reveals that the intelligent city is a process of becoming, of setting objectives, rather than an urban system and a reality already accomplished. Once it is understood as a process, the intelligent city concept brings to the fore two fundamental mechanisms that are part of the process: (1) the emergence of community intelligence due to the diffusion of broadband communication, smart objects, web applications and e-services, and (2) the planning of intelligent places through public policy, strategy development and project implementation. In both cases, the critical element for emerging and planned intelligent cities is the digital space of communication and decision-making, which offers information services, knowledge capabilities and collaboration opportunities inside and outside a community.

In every city the deployment and intensification of digital communication and collaboration is a driver to higher city intelligence. The digital space of cities – as enabler of collective or collaborative intelligence – has been described as a layered edifice of networks, devices, applications and technologies (Living PlanIT, 2010) or as a system of rings superimposed and bonded together, each one having specific characteristics for broadband communication, data management, web and smartphone applications, and e-services (Komninos, 2014). The development of this digital spatiality is an objective per se. For instance, the Digital Agenda for Europe has set the target of wide coverage by broadband networks and services, including, by 2020, fast broadband (>30 Mbps) coverage for all Europeans, 50 percent of households taking broadband subscriptions more than 100 Mbps, and extensive use of the Internet, selling and buying online and using e-government for the majority of the population (Digital Agenda for Europe, 2013).

Digital applications for web and smartphones are being developed for every domain of city life: for the production system composed of industrial and service sectors and districts, work, transaction and exchange processes; for the consumption system, composed of housing, education, health, environment and living conditions; for urban networks and infrastructure that underpins mobility, energy, water and waste; and for city governance, representation, e-democracy, citizen participation and administrative services to citizens. The ICOS repository (Intelligent Cities Open Source, http://icos.urenio.org/) offers a collection of such applications, categorized in the above four urban domains, which are free to download and use. Apps4BCN (http://apps4bcn.cat/en/about) is another collection of applications in 17 different domains that offer solutions to living in Barcelona, which are assessed and rated by a network of experts. Every city already has a portfolio of city-specific applications and solutions at its disposal. As well as these local, platforms, global platforms can be used locally to provide services and solutions, such as Groupon for local discount selling, Kickstarter for funding creative projects, Innocentive
for developing research-based solutions, yet2.com for finding promising new technologies and open innovation opportunities, Mechanical Turk for crowdsourcing skills and work and many others.

Most applications are created bottom-up, along a data input/output structure. Data are provided from various sources, either alone or in combination: people, sensor networks, the web, urban utility providers and the city government. Internal information processing, based on machine intelligence, transforms input data into new information, and the output is transferred to the user. The internal process can cover all knowledge types: information collection, analysis and visualization, learning and skills generation, new knowledge creation, and information dissemination and influence. Software applications work as city endowments, as externalities, infrastructures and collaboration networks that offer advantages because of the presence of neighbors. Their widespread dissemination is a major cultural turn in urban life, emerging from the skill base of cities and sustained by ‘apps4cityX’ contests and open data/open knowledge movements.

Planning for intelligent cities also involves the development of digital applications and solutions, but these are integrated with infrastructure, construction of physical spaces, setting of activities, institutions and regulations. Intelligent city planning is a form of strategic planning with digital projects, starting from context analysis and problem definition and going through objectives and target setting, elaboration of action plans, budgeting, project implementation, monitoring and assessment. The public domain initiates the plan and the institutional framework defines the planning process and the role of stakeholders, organizations, citizens and end-users. The planning process can be conceived as a roadmap of steps that ensures the coordination of the three major components of intelligent cities, namely, the ‘urban space,’ the ‘innovation system of the city’ and the ‘digital space and smart environments.’ The ultimate goal of planning is to create an active community, a living organism or Living Lab, which uses technology and all forms of intelligence – human, collective, artificial – to improve the urban system and achieve higher efficiency and better life conditions.

Looking at intelligent city planning cases, either planning for existing cities or planning greenfield developments, we observe various types of planning. They differ with respect to the area of intervention, the thematic focus of the initiative, the degree of citizens and user involvement, the technology deployed and the priority given to people versus infrastructure. Some major types are:

- Intelligent city planning focused on the entire city and the major sectors of activity, such as Singapore’s Intelligent Nation 2015 Masterplan, which aims to ‘fuel creativity and enable innovation among businesses and individuals by providing an infocomm platform that supports enterprise and talent’ (http://www.ida.gov.sg/Infocomm-Landscape/iN2015-Masterplan).
- Planning focused on the renewal of city districts or clusters, such as the Plan for Intelligent Thessaloniki, which aims to renew a series of city districts in the port area, the historic center, the university campus and the technology district in the eastern part of the city through wireless broadband networks and e-services that improve innovation and entrepreneurship (http://www.urenio.org/el/?p=773).
- Planning focused on the creation or renewal of multiple cores and focal points, such as the plan for Amsterdam Smart City, which continuously introduces new
projects and initiatives in the domains of smart economy, Living Labs, infrastructure, smart mobility, living, society, smart areas and open data (http://amsterdam-smartcity.com/projects/theme/label/smart-areas).

- Planning focused on smart city infrastructure, such as the plan for broadband networks and e-services of Stockholm, which was built around the publicly owned entity Stokab that leases fiber optic networks to telecommunications operators, businesses, local authorities and organizations to deploy digital applications and e-services (https://www.stokab.se/In-english/).

- Planning for new intelligent cities or city districts, where entire new city areas are planned and developed following smart city principles, such as the PlanIT Valley project in Parades, Northern Portugal, which uses the Living PlanIT’S Operating System to integrate all city systems, hubs, buildings and devices (http://www.living-planit.com/default.htm).

Overall, planning for intelligent cities differs from the development of software applications because of its holistic perspective and focus. City problems of growth, sustainability, inclusion and government are addressed by projects that integrate physical, institutional and digital elements and collaborative networks inside and outside the city. Of course, applications and information technology (IT) solutions are an essential component of the planning roadmap, but are a means for actualizing city communities and assisting them in becoming more efficient and innovative. The characterization of intelligent cities as ‘Intelligent Communities’ by the Intelligent Community Forum is accurate and highlights the role of communities in achieving city intelligence and innovation.

10.4 OPERATION: INNOVATION OVER SMART ENVIRONMENTS

The planning or strategy objectives to be found in intelligent or smart cities are about technology and innovation development that lead to more competitive, sustainable and inclusive urban systems. All white papers published by major organizations, institutions and companies corroborate this conclusion. Intelligent cities pursue this goal by deploying broadband networks, ICTs and introducing innovations to all the components of the urban system – the production, consumption, infrastructure and government components. The fundamental operation, therefore, of intelligent cities is to infuse innovation in urban systems by using ICTs, smart environments, digital networking and collaboration; by amplifying the innovation system of cities through technology, which in turn improves the economy, energy, transport, living and governance of cities.

This improvement process takes place through three innovation circuits that work in parallel within intelligent cities. The first innovation circuit concerns the creation of digital spaces and smart environments related to cities. This includes a wide and multilevel construction of broadband networks, smart devices and meters, embedded systems, data management technologies, cloud-based solutions, platforms, applications and e-services. The digital edifice – or digital skin of cities (Rabari and Storper, 2015) – emerges from many uncoordinated initiatives of telecommunication companies, IT developers, producers and users each
one adding some digital component, and/or planning, strategy, actions design and implementation (Tsarchopoulos, 2014). Local solutions co-exist with global platforms and systems customized to local needs and demand (Kakderi and Kourtesis, 2009; Aaltonen et al., 2013). The digital spatiality of cities arises as a dynamic agglomeration of heterogeneous systems and solutions, in the same way that cities arise as agglomerations of heterogeneous practices, buildings and infrastructures.

The range of technologies that drive intelligent/smart cities is a field of controversy. Should electric cars, for instance, be considered as a smart city technology? Are LED lighting, low power semiconductors, wind turbines and renewable energies drivers of smart cities? ICTs are widely accepted as the foundation for intelligent cities because of their capacity to transmit information and to facilitate fundamental knowledge processes such as information gathering, technology transfer and learning, new knowledge creation and information dissemination. Thus, a critical line of demarcation might be identified amongst smart city technologies, distinguishing technologies that alter the intellectual capacity, knowledge base or communicative capacity of the city from those that do not.

This first innovation circuit depends on the human capital, intellectual capacity and creativity in designing digital solutions by the city’s population and organizations; on the ability of the existing territorial innovation system to produce and adapt digital technologies; and on the capability of stakeholders, producers, lead users and citizens to lead, learn, design and develop digital spaces and smart environments. However, the digital spatiality of cities is just a component, a step toward the intelligent city, a necessary but not sufficient condition. Once digital applications, digital spaces and smart environments are in place, they initiate and activate two more circuits of innovation, which derive from the information and knowledge processes introduced by the digital spatiality of cities (Figure 10.2).

Innovation circuit 2 is about improving the city’s system of innovation. In fact, diverse innovation systems co-exist within each city, as each urban sub-system (industrial area, marketplace, financial district, technology district, port and airport hubs, and transportation, energy, water and waste networks) might have its own ecology of organizations, decision-making processes and governance of change. Recently, this fragmentation was increased by liberalization and privatization, leaving many urban clusters and districts under private or public-private autonomous control.

A wide range of digital solutions and applications can be used to improve the governance of innovation, the way cities decide about change, the co-design of the urban environment, such as ‘Improve-my-City’ (http://www.improve-my-city.com/), crowdsourcing platforms (http://www.resultsfromcrowds.com/features/crowdsourcing-landscape/) and City 2.0 (http://www.thecity2.org/). These are a few examples of how technology may contribute to decision-making and stakeholder participation in urban change. At the company level, the Global Innovation 1000 survey of Booz Allen Hamilton has shown that digital tools are influencing every stage of the innovation life cycle, from collecting and analysing customer insights to generating and vetting ideas, designing new products and tracking product success. While productivity tools have reached maturity and are used widely and effectively, in other phases of the innovation process, such as concept development and market promotion, companies are experimenting with customer insight and ideation tools that have transformative potential (Jaruzelski et al., 2013).

The most radical changes that such digital applications, tools and solutions bring
into the innovation system of cities are (1) in creating physical-digital systems or hybrid innovation ecosystems, in which research and development (R&D), funding, design, production and marketing elements of the innovation system have digital ‘partners’ or components, and (2) in mobilizing the capabilities of larger populations, locally and globally, that add creativity, ideas and insights through technology and digital collaboration.

It would be enlightening to revisit the literature on territorial innovation that considers the role of local synergies and innovative milieus (Camagni, 1991), embeddedness (Grabher, 1993), knowledge spillovers and regional interconnectedness, untraded interdependencies (Storper, 1997), regional innovation systems (Cooke et al., 1998), institutional thickness (Amin, 1999), regional learning and tacit knowledge clustering (Morgan, 2004), related variety and knowledge proximity (Boschma, 2005), and examine how digital tools, big data, analytics, web intelligence, global technology marketplaces, social media and alternative (crowd)funding enhance the socio-economic processes of innovation, opening innovation to users, global resources and solutions for optimization of resources.

Innovation circuit 3 begins with other types of digital applications and smart systems that do not intend to change the city’s knowledge dynamics but optimize the way citizens and organizations use the city, public spaces and urban infrastructure. Intelligent transportation systems and GPS guiding urban mobility, sensor-based solutions or social media-based applications for finding parking places in the city, smart energy metering in housing districts, sensor-based street lighting, sensor-based waste collection and route optimization are examples of systems that save resources and optimize resource usage in the city. Similarly, mash-up applications operate to offer information about the city overall, for example, about cultural events, recreation, museums, historic sites.
restaurants, hotels, marketplaces and many other domains of city life. As cities evolve toward larger and more diverse systems, such solutions become necessary to explore environments that are complex and chaotic. They guide the representation that individuals have of the city and the way the city is ‘used’ in light of their own criteria and choices.

Most innovations in circuit 3 are about saving resources and transferring practices from the city’s physical to digital spaces. However, they induce a behavioral change on the citizen or consumer side, diffusing a culture of sustainable resource use, avoiding wasted efforts and of doing more with less. This behavioral change is a sign of higher city intelligence, stemming directly from the culture and social capital of the population.

Innovation circuits 1, 2 and 3 work in parallel and in combination, linking and arraying digital, physical and institutional elements of cities. They form complex architectures of spatial intelligence and problem-solving, articulating city endowments and different types of intelligence, namely, human, collective and machine intelligence. They orchestrate and integrate knowledge tasks, which are distributed among the members of a community; each task may be simple, but the size of the collaboration defines a knowledge change in the entire urban system. They drive innovation not only in the productive system but in every domain and sub-system of cities, such as innovation for the competitiveness of economic clusters and activities; innovation in infrastructure and utility networks for transport, energy, water and waste management; innovation in the quality of life, well-being, pollution prevention, safety in the public space, health and social care; and innovation in governance, decision-making, democracy, administration services offered to citizens, monitoring and measurement of performance. They make the urban system measurable, transparent and accountable.

Intelligent cities potentially offer opportunities for clusters and districts, utility operators, companies, citizens and governments, allowing these organizations, companies or individuals to create their own innovation ecosystems through a combination of physical and digital components. They enable a connectionist and participatory innovation model encompassing not only ‘innovation for everyone’ but ‘innovation by everyone,’ allowing all organizations, institutions and residents to participate in city innovation dynamics.

10.5 CONCLUSION: A PROBLEM-FOCUSED APPROACH TO CITIES AND TERRITORIES

The ‘Intelligent City’ is a system in the making rather than an established urban reality. It should be approached as a new urban planning paradigm or set of business strategies rather than as an operating urban system. To date, intelligent cities offer an attractive prospect, a vision and strategy for the future, a possible way of sustaining innovation in cities and regions rather than an urban pattern, which has already been accomplished and implemented.

The implementation of this urban development paradigm proceeds by way of the convergence of bottom-up approaches, as companies and organizations learn to innovate and operate within smart environments, with top-down initiatives. Planning for intelligent cities follows a typical strategic planning roadmap (analysis, vision, strategy, action plan, implementation) in which the action plan is composed of ‘digital projects,’ such as
broadband networks, sensor networks, digital learning and skills, open data, software apps and e-services: but the impact of this urban digital layer is wider.

Much more than a set of data and smart technologies rolled out across cities, intelligent cities are territorial systems of innovation, which are enhanced by digital collaboration, become global in the mobilization of resources and market reach, and are driven by user innovations and large datasets. Such physical-digital systems of innovation disrupt one industrial sector and market after another. Currently, imbalanced urban markets of transportation and hospitality are being reinvented by disruptive start-ups such as Uber and Airbnb. The digital disruption wave reaches the housing, financial and insurance markets. All sectors of the economy are affected by ICTs lowering production costs, online marketing and distribution channels, and the circulation of digital identities of products and services.

Intelligent cities also enable and facilitate collaborative business models, the sharing of underutilized assets, shifts from centralized organizations to decentralized networks of producers, the on-demand production of services and products and a shift from a culture of ownership to on-demand access (Botsman, 2015). Supported by digital technology, innovation is becoming demand- and user-driven, while every company working in a smart environment can profit from digital skills available in India, suppliers in China, funding from London and the USA, and product distribution across global markets and online platforms. The challenge is to understand this transformative logic and to conceptualize working models of such physical-digital territorial systems of innovation in order to prepare stakeholders, citizens, organizations and institutions for the disruption they introduce.

The new urban system that the intelligent city paradigm is gradually revealing is characterized by the substitution of physical space and infrastructure by digital ones, leading to substantial economies of fixed capital investment and more sustainable behaviors in the use of city resources. In parallel, the city is becoming a measurable system due to digital traces left by digital identities and digital practices across the city.

The intelligent or smart city raises great expectations: the city will become more efficient and sustainable: intelligent cities will have an advantage in the global competition for investment and talent; the stress of growing urban populations on city infrastructure and resources will be reduced; energy efficiency will be improved and carbon emissions reduced; society will become more coherent and participatory . . . Expectations notwithstanding, the real impact of smart city implementation has yet to be documented with metrics and indexes. Metrics might be Internet penetration, broadband speed, software applications, use of e-services, open data volume, diffusion of platform-based business models and others. Above all, these metrics should capture the innovation and problem-solving capacity of cities and measure the outcome of adding an urban digital layer to the fundamental urban systems of production, consumption, infrastructure and government. Lessons learned from cities in the vanguard of intelligent city roll-out indicate that city intelligence, innovation and higher efficiency do not only reside in smart technologies and software applications but in the knowledge architectures that connect capabilities distributed among people, organizations, institutions, smart city objects and the smart infrastructure of cities.
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11. Geography, skills and career patterns at the boundary of creativity and innovation: digital technology and creative arts graduates in the UK

Roberta Comunian, Alessandra Faggian and Sarah Jewell

11.1 INTRODUCTION

In economics, and especially in the regional economic literature, there is a general acknowledgement of the key role played by knowledge and skills (often referred to as ‘human capital’) in fostering local innovation (Desrochers, 2001; Faggian and McCann, 2009). However, the way human capital is measured has been a source of heated debate in recent years. Several contributions by Florida and co-authors (Florida, 2002b; Stolarick and Florida, 2006; Florida et al., 2008) introduced the ‘creative class’ concept, and questioned the idea that education is the best measure of the skills and knowledge embodied in workers: they argue that what workers ‘actually do’ – that is, their occupation – should be taken into account instead. Although not without its critics (see Comunian et al., 2010b for a review), the idea of looking at ‘creativity’ as a source of innovation and development found fertile ground in many countries including the UK where ‘creative industries’ – a term introduced in 2001 by the Department of Culture, Media and Sport (DCMS) – have often been put forward as key drivers for economic growth.

However, although the creative industries concept rapidly took central stage in both policy making and academic research, many questioned the rationale (and the need) behind the shift from cultural to creative industries (Garnham, 2005), and particular attention was paid to the role that digital, information and media technologies play in this newly defined sector (Oakley, 2006; Taylor, 2006). Crucial in the DCMS definition of creative industries is the role of individual talent. Creative industries are defined as ‘those industries which have their origin in individual creativity, skill and talent and which have a potential for wealth and job creation through the generation and exploitation of intellectual property’ (DCMS, 2001, p. 4).

Such industries include ‘advertising, architecture, the art and antiques market, crafts, design, designer fashion, film and video, interactive leisure software, music, the performing arts, publishing, software and computer services, television and radio’: innovations and new opportunities developed in and by these service industries were presented as the new driver of the UK economy. Indeed, creative industries – like high-technology manufacturing in the 1980s and early 1990s (Massey et al., 1991) – are attracting policymakers’ attention because they are at the forefront of innovation, introducing and capitalizing upon new markets, new technology and new consumer tastes. And, like for high-technology manufacturing in the past, UK regions do not benefit equally from the presence of creative industries: many authors have pointed out the uneven geography of creative and cultural production in the UK, with London playing a leading role, and many regions struggling to even appear on the stage (Oakley, 2006; Knell and Oakley,
Critical commentators recognized the changing pressures under which DCMS was operating, and its new focus on commercially driven cultural products, with specific attention paid to the inclusion of sectors such as interactive leisure software that have strong technology and intellectual property dimensions (Oakley, 2006). While at the end of the 1990s the policy shift was from cultural to creative industries, more recently there has been a further, although less pronounced, shift from creative to digital industries (DCMS and BIS, 2009). This is driven by the strong performance of the technology-driven companies within the creative industries, where software and electronic publishing accounts for the most gross added value out of all the creative industries (DCMS, 2010).

In this evolving policy and business framework it is important to ask what role digital skills and human capital play in the creative industries. The chapter argues that a better understanding of human capital and skills in the ‘digital technology’ sector is key to understand and truly capture the impact of technological changes on these innovative companies and on the economy overall. Previous contributions, such as Comunian et al. (2010), demonstrate the contradiction between the assumed key economic importance of the creative class (Florida, 2002a) and the low financial rewards and career uncertainty of the core cultural workforce (Menger, 1999). Nonetheless, there is almost no research on the career prospects and job opportunities for graduates specialized in digital technology, nor on their contribution to creative industries. One exception is a report by NESTA (2011) that considers the link between skills and two digital industries: video games and visual effects. It highlights the importance of higher education and emphasizes the important overlap between artistic and STEM (Science, Technology, Engineering and Maths) skills. It is particularly important therefore to understand the connections between digital skills and creative industries.

This chapter argues that in order to further our understanding of the role and importance of digital technologies in the creative economy, we need to first deepen our understanding of the role played by digital skills in relation to, and in comparison with, creative skills in this sector. We particularly want to identify the geographic dynamics and concentration of ‘digital human capital’ and its integration with local creative economies.

11.2 RESEARCH LANDSCAPE: CREATIVE INDUSTRIES BETWEEN CREATIVE AND DIGITAL TECHNOLOGY SKILLS

Recent literature highlights the need for better understanding of the connection between creative industries, creative work and digital technology skills, and their relation to innovation (Bakhshi et al., 2008). However, an ingredient central to all of these is the people—and more specifically young graduates entering the workforce—with the skills required to propel this creativity and innovation. Their career prospects and skillsets are often lost in the rhetoric surrounding the end products and services, and the value-added, generated by creative industries. We tackle this gap by first looking at the working conditions of creative and media workers and, second, by addressing the role played by digital technology in the creative industries, especially in relation to the more recent policy framework.
The literature widely recognizes that careers in the creative sector tend to be unconventional, often relying on a mix of part-time and transient jobs and often resulting in low wages. However, our understanding of how these patterns might be different across different creative industry sub-sectors and across the range of occupations involved is still limited. There are many studies looking at the labour market adversities faced by artists and cultural workers, from unstructured working patterns, to oversupply and lower salaries (Menger, 1999; McRobbie, 2002; Comunian, 2009). Although this research provides important insights into some key issues faced by creative workers, it groups artistic and new digital professionals into one single, and very heterogeneous, category. Some authors have tried to look more closely at workers in the digital and media industries (Pratt, 2000; Christopherson, 2002, 2004; Gill, 2002; Neff et al., 2005), but their contributions generally rely on qualitative data and case studies, which do not allow for comparative work across different creative disciplines. Building on initial work by Comunian et al. (2010), the current chapter addresses this shortcoming by exploring differences in labour market performance and career patterns for digital technology graduates.

Another important dimension to consider is the complex interconnection between digital technologies and creative industries, together with its related policy implications. Potts and Cunningham (2008) question whether ‘creative industries’ should be considered as a sector of the economy, arguing instead that creative industries are part of the national innovation system, contributing to the generation of ideas and technology. However, it has proved arduous for researchers to assess and measure interconnections between creative industries and the broader economy. Knowledge about the skill composition of creative industries is still limited, and although the literature recognizes the complex interplay between artistic and technological skills needed in this sector (Healy, 2002) this remains an under-researched area. The use of digital technology is a driving factor of creative industries. Skillset (2010) highlights that in creative media industries the most common areas of training identified by employers relate to new and digital technology (one in four people). A recent report from NESTA looking at video games and visual effects sectors suggests: ‘There are already many university courses purporting to provide specialist training for video games and visual effects. But most of these courses are flawed, leaving those graduating from them with poor job prospects’ (NESTA, 2011, p. 5). This highlights the importance of considering higher education and skill development in order to better understand the sector and the role played in it by digital skills.

The two areas of the literature summarized above – one on the labour market, the other on skills – highlight the need for improving our understanding of the role of digital skills in creative industries. Furthermore, geography plays an important role in the creative economy and research highlights the uneven distribution of higher education provision (Comunian and Faggian, 2014; Comunian et al., 2014) and, even more so, of job opportunities in the creative sector (NESTA, 2009; Lee and Drever, 2013) with London playing a predominant role (Knell and Oakley, 2007; Faggian et al., 2013).

In light of these considerations, the chapter addresses three questions in relation to the role played by digital and technological skills – represented by digital technology graduates – in the creative industries and its workforce.

1. What is the role played by digital technology graduates in the creative labour market and what is the geography of provision of these digital technology courses?
2. What are the sectors entered and jobs undertaken by digital technology graduates, and where do they concentrate?
3. What factors influence the probability of digital technology graduates taking a creative job or working in the creative industries, and what influences the salary they earn?

11.3 DATA, DEFINITIONS AND METHODOLOGY

11.3.1 HESA Data

Our analysis is based on micro data from the ‘Destinations of Leavers from Higher Education’ (DLHE) survey matched to student record data (collected as part of the ‘Students in Higher Education’ survey), both collected by the UK Higher Education Statistical Agency (HESA). The DLHE survey, targeted towards British domiciled students, is distributed every year to all UK institutions to collect information about their graduates’ employment activities six months after graduation. For this chapter, we focus on British domiciled undergraduate students who graduated in 2005 (with employment data for 2006). Since we focus on employment patterns, these two years are particularly good as they refer to the pre-recession period. The recession, which took place following the 2007 credit crunch, had a negative effect on graduates’ employment in general (Shattock, 2010), but it might have impacted graduates from different disciplines differently, thereby biasing our results.

The DLHE survey includes information on the graduate’s employment: annual salary level, employer sector code (4-digit Standard Industrial Classification (SIC) code), job occupational code (4-digit Standard Occupational Classification (SOC) code) and location of employment (postcode and government office region of employment). From the student record data, we obtain information on graduates’ personal characteristics (such as gender, age, ethnicity, disability), subject of study (at the 4-digit Joint Academic Coding System (JACS) code), degree results and type of institution attended.

Our final DLHE sample includes 207,271 records (with a response rate of 77 per cent from the sample of all British graduates eligible for a DLHE return). Our sample size reduces slightly to 199,650 when we exclude those graduates who provide an explicit refusal to answer the DLHE survey or who undertook combined subjects (since it is not possible to classify them). While the figures we present for graduates within the creative industries are only a sub-set of the overall creative workforce, there are key supporting factors highlighting the relevance of these data collected for creative industries in the UK (Skillset, 2010): the workforce is young (42 per cent in creative media is under 35 years old, and 52 per cent in the overall creative and cultural sector is under 40 years) and highly skilled (57 per cent in creative media and 54 per cent in the creative and cultural sector have a degree or equivalent qualification). These data, while they focus on a specific innovative industry, provide insight into wider questions concerning the training and labour market geography of skilled entrants into innovative fields.
11.3.2 Definitions: Subjects and Creative Industries and Occupations

In order to fully explore the role played by different skills in the creative industries, we group graduates into three categories according to their main subject of study (identified by HESA's JACS codes), with particular focus on digital technology compared to the other subject groups. Our subject definitions are as follows:

1. digital technology (selected JACS codes from G, H, J)
2. creative arts and design (all JACS codes beginning with W)
3. other (all other JACS codes).

In line with previous work (Comunian et al., 2010b; Abreu et al., 2012) our creative industry definition stems from the DCMS definition (1999, 2001). We use a creative jobs approach à la Cunningham et al. (2004) and consider both creative jobs within the creative industries and creative jobs in other sectors. We use the initial DCMS definition based on 4-digit SIC codes (DCMS, 2001) and supplement it with other creative workers in occupations based in sectors outside the creative industries – as identified by a more recent DCMS document (DCMS, 2010). Moreover, we also take on board some of the criticisms of this DCMS definition levelled by NESTA (2008b). Following NESTA (2008b), we therefore further classify creative jobs as being:

- Specialized: in a creative occupation within the creative industries;
- Supportive: in a non-creative occupation within the creative industries;
- Embedded: in a creative occupation outside the creative industries.

We also break down creative jobs into sub-sector categories, using the following groups: advertising, architecture and design engineers, design, designer fashion and crafts, film, TV, radio and photography, music and visual performing arts, publishing, software, computer games and electronic publishing, libraries, museums and cultural activities. Examining sub-groups is important given creative jobs are very heterogeneous and past research has shown substantial differences between sub-groups (McGranahan et al., 2011).

11.3.3 Methodology

The chapter employs a three-step methodology. First, we use descriptive statistics to identify basic patterns and trends in our sample, for example, how many graduates enter the labour market and how many specifically enter creative jobs or jobs in creative industries, how many graduates from digital technology and how many from other subjects enter creative industries and so on. We consider also the role of geography in the study and employment patterns.

Second, we present some descriptive statistics focused specifically on the differences across creative sub-sectors. We are particularly interested in uncovering what sub-sectors of the creative economy employ more digital technology graduates and which sectors offer better job opportunities, for example, a graduate level job.

Finally, as in previous contributions (Comunian et al., 2011; Faggian et al., 2013), we
examine factors affecting the choice of entering the creative sector. We use a logit model to identify the factors influencing the probability of digital technology graduates and other graduates entering a creative job, as in equation 11.1:

\[
\ln \left( \frac{P_1}{P_0} \right) = \beta_1 X + \epsilon \tag{11.1}
\]

\(X\) is a vector of explanatory variables and \(\epsilon\) is a random error term. Our explanatory variables include gender, age, ethnicity, subject group, degree classification, institution type and region of employment. We also run equation 11.1 separately for each of the three subject groups, thereby excluding subject group from the explanatory variables.

Finally, we estimate Mincerian-type earning equations (11.2 and 11.3) to identify the key determinants of salary differences across graduates.

\[
\ln W = \beta_1 X + \epsilon \tag{11.2}
\]

\[
\ln W = \beta_1 X + \beta_2 SEC + \epsilon \tag{11.3}
\]

The dependent variable is the natural logarithm of earnings (\(W\)), \(X\) is a vector of explanatory variables and \(\epsilon\) is a random error term. We make use of the salary variable in the DLHE survey (with the ‘full-time equivalent’ asked for those working part time). We exclude those who claim to earn less than the national minimum wage\(^2\) and, following Chevalier (2011), those who earn £60,000 or more. \(X\) contains the same set of controls as in equation 11.1 plus mode of employment (full time, free-lance/self-employed; part time/unpaid work). Equation 11.3 adds creative sub-sector dummy variables as listed in Sub-section 11.3.1

### 11.4 RESULTS

#### 11.4.1 Descriptive Statistics

Our sample includes about 18 per cent of students in either digital technology (7.62 per cent) or creative arts (10.55 per cent). This percentage may be below current numbers as many universities have seen an increase in students in these subject areas in recent years (Heartfield, 2005). As Table 11.1 shows, the provision of creative courses is not uniform across the country. Greater London and the South East attract the most students in digital and creative disciplines. However, other regions also play a role. The percentage of ‘creative arts’ students is above 10 per cent in both the North West and East Midlands, while ‘digital technology’ students, outside Greater London (19.19 per cent) are based in Yorkshire and the Humber (10.69 per cent), the North West (10.23 per cent) and the South East (10.03 per cent).

Past research has shown that creative graduates tend to have poor labour outcomes (Comunian et al., 2010b; McGranahan et al., 2011; Abreu et al., 2012). Table 11.2 shows that digital technology graduates are similar to creative arts graduates, but with some exceptions.

First, digital technology students have the highest unemployment rate among all
graduates (10.30 per cent compared to 5.56 per cent for graduates from other subjects),
even compared with creative arts students (9.54 per cent). Second, digital technology
students are less likely to have part-time (7.44 per cent) or voluntary/unpaid jobs (0.59
per cent) compared to other graduates (7.61 per cent and 0.87 per cent) and especially
compared to other creative arts graduates (12.64 per cent and 1.25 per cent). Conversely,
digital technology graduates are more likely than other creative arts graduates to be in
full-time employment (59.44 per cent against 52.09 per cent). The higher unemployment
rate for digital technology graduates can be explained in different ways. It could be linked
to an oversupply of students in these subjects, to being overspecialized for the role offered
in the creative sector, or to being willing to wait longer in expectation of a full-time job.
While our previous knowledge of creative graduates’ career patterns remains relevant, it

<table>
<thead>
<tr>
<th>Region of study</th>
<th>Digital technology</th>
<th>Creative arts</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>North East</td>
<td>5.91</td>
<td>3.59</td>
<td>5.41</td>
<td>5.25</td>
</tr>
<tr>
<td>North West</td>
<td>10.23</td>
<td>10.93</td>
<td>11.27</td>
<td>11.15</td>
</tr>
<tr>
<td>Yorkshire and the Humber</td>
<td>10.69</td>
<td>8.19</td>
<td>10.57</td>
<td>10.33</td>
</tr>
<tr>
<td>East Midlands</td>
<td>7.24</td>
<td>10.65</td>
<td>8.63</td>
<td>8.74</td>
</tr>
<tr>
<td>West Midlands</td>
<td>8.29</td>
<td>6.33</td>
<td>7.23</td>
<td>7.22</td>
</tr>
<tr>
<td>East of England</td>
<td>5.16</td>
<td>4.31</td>
<td>4.63</td>
<td>4.64</td>
</tr>
<tr>
<td>London</td>
<td>19.19</td>
<td>18.84</td>
<td>12.20</td>
<td>13.43</td>
</tr>
<tr>
<td>South East</td>
<td>10.03</td>
<td>15.18</td>
<td>12.49</td>
<td>12.59</td>
</tr>
<tr>
<td>South West</td>
<td>7.12</td>
<td>9.49</td>
<td>8.03</td>
<td>8.11</td>
</tr>
<tr>
<td>Wales</td>
<td>4.33</td>
<td>6.50</td>
<td>6.05</td>
<td>5.97</td>
</tr>
<tr>
<td>Scotland</td>
<td>8.62</td>
<td>4.79</td>
<td>10.35</td>
<td>9.63</td>
</tr>
<tr>
<td>Northern Ireland</td>
<td>3.20</td>
<td>1.22</td>
<td>3.13</td>
<td>2.94</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of observations</th>
<th>Digital technology</th>
<th>Creative arts</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage (%)</td>
<td>7.62</td>
<td>10.55</td>
<td>81.84</td>
</tr>
<tr>
<td>Labour market entrants</td>
<td>74.04</td>
<td>73.62</td>
<td>73.11</td>
</tr>
<tr>
<td>Full-time paid work</td>
<td>59.44</td>
<td>52.09</td>
<td>55.41</td>
</tr>
<tr>
<td>Part-time paid work</td>
<td>7.44</td>
<td>12.64</td>
<td>7.61</td>
</tr>
<tr>
<td>Voluntary/unpaid work</td>
<td>0.59</td>
<td>1.25</td>
<td>0.87</td>
</tr>
<tr>
<td>Work and study</td>
<td>6.58</td>
<td>7.63</td>
<td>9.23</td>
</tr>
<tr>
<td>Non-labour market entrants</td>
<td>25.96</td>
<td>26.38</td>
<td>26.89</td>
</tr>
<tr>
<td>Further study only</td>
<td>10.59</td>
<td>10.47</td>
<td>15.19</td>
</tr>
<tr>
<td>Assumed to be unemployed</td>
<td>10.30</td>
<td>9.54</td>
<td>5.56</td>
</tr>
<tr>
<td>Not available for employment</td>
<td>3.77</td>
<td>4.55</td>
<td>5.10</td>
</tr>
<tr>
<td>Other</td>
<td>1.30</td>
<td>1.82</td>
<td>1.05</td>
</tr>
</tbody>
</table>
is clear that digital technology graduates’ experiences differ from those of creative arts graduates, and it is important to explore these differences further.

### 11.4.2 Creative Labour Market and Digital Technology Graduates

After viewing the general trends and work patterns of the different types of graduate, we now turn to their interconnection with the creative sector. Table 11.3 shows a breakdown of sectors employing creative graduates. Creative graduates are broken down into three sub-categories as above: digital technology, creative arts and other.

Only about a third of digital technology graduates (39.35 per cent) and creative arts graduates (38.34 per cent) find a job in the creative sector. The other two-thirds find employment outside the sector, but there are some differences between digital technology and creative arts graduates. Almost 20 per cent of digital technology graduates find employment in the science, engineering and technology industry, while creative arts graduates entering a non-creative sector tend to find work in the education sector.

Interesting patterns also emerge when looking at sub-sectors within the creative sector. Of the 39.35 per cent of digital technology graduates who enter the creative sector, over three-quarters (77.33 per cent) enter one specific sub-sector, that is, the software, electronic games and publishing sector. This is clearly linked to their high level
of specialization, but also to the fact that – due to the nature and size of creative industries – digital work tends to be outsourced rather than incorporated in the functions of other sectors.

In terms of the type of creative job performed, that is, specialized, supportive or embedded (last three rows of Table 11.3), different subject groups appear to play a different role within the creative sector. For example, 52.69 per cent of digital technology graduates are embedded within non-creative industries (compared to 34.22 per cent of creative arts and 37.89 per cent of other graduates), with 33.14 per cent in specialized roles (creative arts are the most likely to be in specialist roles at 45.40 per cent) and only 14.16 per cent in supportive roles.

This seems to suggest that non-creative sectors are able to embed digital technology graduates, providing them with creative occupations even outside creative industries. Furthermore, it also implies an acknowledgement across the wider economy of the value of the creative skills of digital graduates (for example, a web designer in a manufacturing industry). Finally, it is worth noting that digital technology graduates are less likely to be in specialized positions, which might suggest that it is a challenge for them to enter core creative occupations within creative industries, which is comparable to the position occupied by the general ‘others’ group. Compared also to the creative arts group, digital technology graduates do not occupy as many specialized positions and this might be linked also to a less recognizable role of these graduates in creative occupations (especially outside the core software sector).

Table 11.4 shows that the geography of creative jobs is uneven. Only five regions have a higher percentage of digital graduates in creative than non-creative jobs: London (24.13 per cent versus 22.28 per cent), South East (15.86 per cent versus 10.87 per cent), South West (6.93 per cent versus 5.85 per cent), East of England (6.47 per cent versus

Table 11.4  The geography of creative jobs by subject group

<table>
<thead>
<tr>
<th>Region of job</th>
<th>Digital technology</th>
<th>Creative arts</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-creative jobs (%)</td>
<td>Creative jobs (%)</td>
<td>Non-creative jobs (%)</td>
</tr>
<tr>
<td>North East</td>
<td>4.76</td>
<td>3.25</td>
<td>3.05</td>
</tr>
<tr>
<td>North West</td>
<td>11.07</td>
<td>9.36</td>
<td>11.24</td>
</tr>
<tr>
<td>Yorkshire and the Humber</td>
<td>8.97</td>
<td>7.8</td>
<td>7.8</td>
</tr>
<tr>
<td>East Midlands</td>
<td>6.08</td>
<td>5.46</td>
<td>7.18</td>
</tr>
<tr>
<td>West Midlands</td>
<td>8.49</td>
<td>6.4</td>
<td>8.61</td>
</tr>
<tr>
<td>East of England</td>
<td>5.61</td>
<td>6.47</td>
<td>7.57</td>
</tr>
<tr>
<td>London</td>
<td>22.28</td>
<td>24.13</td>
<td>17.98</td>
</tr>
<tr>
<td>South East</td>
<td>10.87</td>
<td>15.86</td>
<td>14.98</td>
</tr>
<tr>
<td>South West</td>
<td>5.85</td>
<td>6.93</td>
<td>9.63</td>
</tr>
<tr>
<td>Wales</td>
<td>4.28</td>
<td>3.42</td>
<td>5.67</td>
</tr>
<tr>
<td>Scotland</td>
<td>8.88</td>
<td>7.17</td>
<td>4.67</td>
</tr>
<tr>
<td>Northern Ireland</td>
<td>2.86</td>
<td>3.75</td>
<td>1.62</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 11.5  Results of the logit model of the likelihood of getting a creative job (odds ratios)

<table>
<thead>
<tr>
<th></th>
<th>All subjects</th>
<th>Digital technology</th>
<th>Creative arts</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal Characteristics</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.636***</td>
<td>0.648***</td>
<td>0.622***</td>
<td>0.710***</td>
</tr>
<tr>
<td></td>
<td>[−13.282]</td>
<td>[−7.268]</td>
<td>[−10.513]</td>
<td>[−5.564]</td>
</tr>
<tr>
<td>Age on graduation (ref: 21 and under)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22–24</td>
<td>1.057</td>
<td>1.179**</td>
<td>1.333***</td>
<td>0.932</td>
</tr>
<tr>
<td></td>
<td>[1.609]</td>
<td>[2.188]</td>
<td>[4.569]</td>
<td>[−1.258]</td>
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<tr>
<td>25+</td>
<td>0.737***</td>
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<td>1.471***</td>
<td>0.771**</td>
</tr>
<tr>
<td></td>
<td>[−5.252]</td>
<td>[−0.712]</td>
<td>[5.100]</td>
<td>[−2.521]</td>
</tr>
<tr>
<td>Disabled</td>
<td>1.119***</td>
<td>1.082</td>
<td>1.140**</td>
<td>1.157**</td>
</tr>
<tr>
<td></td>
<td>[3.623]</td>
<td>[0.876]</td>
<td>[2.316]</td>
<td>[2.239]</td>
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<tr>
<td><strong>Ethnicity (ref: White)</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
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<td>0.557***</td>
<td>0.561***</td>
<td>0.428***</td>
</tr>
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<td>[−9.747]</td>
<td>[−5.566]</td>
<td>[−3.777]</td>
<td>[−5.472]</td>
</tr>
<tr>
<td>Asian</td>
<td>0.536***</td>
<td>0.571***</td>
<td>0.844*</td>
<td>0.735**</td>
</tr>
<tr>
<td></td>
<td>[−10.146]</td>
<td>[−7.800]</td>
<td>[−1.645]</td>
<td>[−2.567]</td>
</tr>
<tr>
<td>Mixed</td>
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<td>1.075</td>
<td>1.202</td>
<td>0.720*</td>
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<td>[−0.974]</td>
<td>[0.333]</td>
<td>[1.253]</td>
<td>[−1.687]</td>
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<tr>
<td>Other</td>
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<td>0.781</td>
<td>0.989</td>
<td>0.738</td>
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<td>[−2.155]</td>
<td>[−1.194]</td>
<td>[−0.048]</td>
<td>[−1.345]</td>
</tr>
<tr>
<td><strong>Subject group (ref: Other subjects)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital technology</td>
<td>5.165***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[30.235]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creative arts</td>
<td>4.723***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[29.658]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Degree classification (ref: Upper second)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First</td>
<td>1.273***</td>
<td>1.528***</td>
<td>1.610***</td>
<td>1.443***</td>
</tr>
<tr>
<td></td>
<td>[7.166]</td>
<td>[7.008]</td>
<td>[7.396]</td>
<td>[5.342]</td>
</tr>
<tr>
<td>Lower second</td>
<td>0.683***</td>
<td>0.576***</td>
<td>0.680***</td>
<td>0.712***</td>
</tr>
<tr>
<td></td>
<td>[−17.424]</td>
<td>[−9.106]</td>
<td>[−8.681]</td>
<td>[−6.767]</td>
</tr>
<tr>
<td>Third/pass</td>
<td>0.519***</td>
<td>0.398***</td>
<td>0.496***</td>
<td>0.619***</td>
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<tr>
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<td>[−13.548]</td>
<td>[−10.943]</td>
<td>[−7.795]</td>
<td>[−4.590]</td>
</tr>
<tr>
<td>Other degree class</td>
<td>0.417***</td>
<td>0.540***</td>
<td>0.825</td>
<td>1.871**</td>
</tr>
<tr>
<td></td>
<td>[−7.098]</td>
<td>[−4.079]</td>
<td>[−0.894]</td>
<td>[2.138]</td>
</tr>
<tr>
<td><strong>Institution Type (ref: New University)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russell Group</td>
<td>1.012</td>
<td>1.266**</td>
<td>0.845*</td>
<td>0.839</td>
</tr>
<tr>
<td></td>
<td>[0.147]</td>
<td>[2.462]</td>
<td>[−1.766]</td>
<td>[−1.424]</td>
</tr>
<tr>
<td>Other old</td>
<td>0.947</td>
<td>1.193**</td>
<td>1.069</td>
<td>0.629***</td>
</tr>
<tr>
<td></td>
<td>[−0.834]</td>
<td>[2.294]</td>
<td>[0.618]</td>
<td>[−3.998]</td>
</tr>
<tr>
<td>HE/FE colleges</td>
<td>0.859</td>
<td>0.726*</td>
<td>1.07</td>
<td>0.661***</td>
</tr>
<tr>
<td></td>
<td>[−1.418]</td>
<td>[−1.735]</td>
<td>[0.558]</td>
<td>[−2.583]</td>
</tr>
<tr>
<td><strong>Region of Employment (ref: South East)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North East</td>
<td>0.742***</td>
<td>0.473***</td>
<td>1.167</td>
<td>0.716*</td>
</tr>
<tr>
<td></td>
<td>[−2.960]</td>
<td>[−4.481]</td>
<td>[1.028]</td>
<td>[−1.840]</td>
</tr>
<tr>
<td>North West</td>
<td>0.806***</td>
<td>0.569***</td>
<td>1.046</td>
<td>0.797*</td>
</tr>
<tr>
<td></td>
<td>[−3.030]</td>
<td>[−5.691]</td>
<td>[0.379]</td>
<td>[−1.777]</td>
</tr>
</tbody>
</table>
5.61 per cent) and Northern Ireland (3.75 per cent versus 2.86 per cent). The market for creative jobs for arts graduates is even more concentrated, with only London and Scotland offering more opportunities in creative jobs than non-creative jobs.

### 11.4.3 Digital Technology Graduates in the Creative Economy: Jobs and Salary Profile

After analysing the overall dynamics and job patterns of digital technology graduates, we now model the likelihood of obtaining a creative job – for all graduates and for each type of graduate separately – using a logit model (equation 11.1). Results – expressed as odds ratios – are presented in Table 11.5.

Digital technology graduates are over five times more likely to enter a creative job than other graduates. The same is true of creative arts graduates, with an odds ratio just below five. Studying in a Russell Group (research intensive) or old university also makes digital technology graduates significantly more likely to get employment in a creative sector (about 26.6 per cent more likely), while the same does not apply to creative arts graduates. However, this last result might be due to the fact that creative arts courses tend to be heavily concentrated in post-1992 or ‘new’ universities.

London emerges (as it does in the descriptive analysis above) as the hot-spot for

<table>
<thead>
<tr>
<th>Table 11.5 (continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All subjects</td>
</tr>
<tr>
<td>Personal Characteristics</td>
</tr>
<tr>
<td>Yorkshire &amp; Humberside</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>East Midlands</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>West Midlands</td>
</tr>
<tr>
<td>East</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>London</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>South West</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Wales</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Scotland</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Northern Ireland</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Observations** 129,645 10,047 13,878 25,902
**Log likelihood** -48,875 -6,312 -8,591 -12,712
**LR Chi²** 4,356 1,022 925 679

**Pseudo r-squared** 0.13 0.0633 0.0624 0.0512

**Note:** Robust t statistics in square brackets; standard errors clustered at institution level; *** p < 0.01, ** p < 0.05, * p < 0.1.
creative employment, but more so for arts than for digital technology graduates, who instead seem to find jobs across a wider area that includes not only London but also the South East and East of England. This could partly be because digital technology graduates work remotely from home, and partly because the functional units (establishments) they are in may be more focused on the technical aspects of creation and less reliant on urban buzz. However, even though their jobs are somewhat ‘footloose’, they still benefit from having large cities (such as London) nearby for occasional face-to-face meetings. The same does not apply to creative arts graduates who might require physical infrastructure such as theatres, exhibition centres and museum and so on.

Alongside the opportunity to enter a creative career, the economic rewards of such a career are also important. Table 11.6 shows the results of the basic Mincerian earning equations. Model 1 (equation 11.2) looks at the salaries of the whole sample of graduates and includes individual, course and university explanatory variables. Model 2 (equation 11.3) also adds controls for the type of creative sub-sector entered after graduation. Models 3 and 4 are the same as Models 1 and 2 but restricted to the sample of graduates who entered a creative job.

As expected, digital technology graduates earn more than creative arts graduates and significantly more if they enter a creative job (an increase of about 7 per cent by looking at the difference between Models 1 and 3). Graduating from a research-intensive university such as the ones belonging to the Russell Group carries an average ‘premium’ of 7.6–7.7 per cent across all occupations and a premium between 3.3 and 4 per cent for creative job (depending on whether the sub-sectors are controlled for, Model 4, or not, Model 3). A closer look at the creative sub-sectors shows substantial differences among them. While an occupation in the ‘software’ sector is associated with a salary premium that ranges between 9.6 per cent and 11.8 per cent according to the model specification, being in the music, film, publishing, design or libraries sectors is associated with a salary penalty ranging from a minimum of 5.8 per cent (design in creative jobs) to as much as 18.2 per cent (librarians in creative jobs). This is good news for digital graduates whose preferred creative sub-sector is indeed software (as shown in Table 11.3).

Although Table 11.6 reports the results only on the variables of interest for our analysis, other results on individual characteristics are significant. For instance, being a female is associated with a salary penalty. This is a well-known result in labour economics studies employing a Mincerian-type methodology and it has also been verified in other studies focusing on creative graduates (Comunian et al., 2010b).

### 11.5 DISCUSSION AND CONCLUSIONS

The main aim of this chapter is to better understand the role played by digital technology human capital and skills in the creative sector, with a particular focus on the differences between digital technology graduates and creative arts graduates. Our data highlight that, although the creative sector employs graduates from different disciplines, creative arts and digital technology graduates still constitute the majority of employees in this sector.

Digital technology graduates are, as expected, predominantly employed in the software sector. They are only present in limited numbers in other creative sub-sectors,
Table 11.6 Results of the Mincer earning equations (variables of interests)

<table>
<thead>
<tr>
<th></th>
<th>All jobs</th>
<th>Creative jobs only</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>Subject group (ref: other)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital technology</td>
<td>0.033***</td>
<td>−0.007</td>
</tr>
<tr>
<td></td>
<td>[3.797]</td>
<td>[−0.773]</td>
</tr>
<tr>
<td>Creative arts</td>
<td>−0.149***</td>
<td>−0.139***</td>
</tr>
<tr>
<td></td>
<td>[−21.011]</td>
<td>[−19.545]</td>
</tr>
<tr>
<td>Degree classification (ref: Upper second)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First</td>
<td>0.059***</td>
<td>0.056***</td>
</tr>
<tr>
<td></td>
<td>[12.179]</td>
<td>[11.735]</td>
</tr>
<tr>
<td>Lower second</td>
<td>−0.030***</td>
<td>−0.030***</td>
</tr>
<tr>
<td></td>
<td>[−7.515]</td>
<td>[−7.726]</td>
</tr>
<tr>
<td>Third/pass</td>
<td>−0.01</td>
<td>−0.01</td>
</tr>
<tr>
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<td>[−0.416]</td>
<td>[−0.403]</td>
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<td>0.240***</td>
</tr>
<tr>
<td></td>
<td>[7.901]</td>
<td>[7.883]</td>
</tr>
<tr>
<td>Institution Type (ref: New University)</td>
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<td></td>
</tr>
<tr>
<td>Russell Group</td>
<td>0.077***</td>
<td>0.076***</td>
</tr>
<tr>
<td></td>
<td>[7.105]</td>
<td>[7.147]</td>
</tr>
<tr>
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<td>0.014</td>
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<tr>
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<td>−0.013</td>
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<tr>
<td></td>
<td>[−1.235]</td>
<td>[−1.068]</td>
</tr>
<tr>
<td>Creative core sector (ref: non-creative job/advertising)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advertising</td>
<td>−0.009</td>
<td>−</td>
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<tr>
<td></td>
<td>[1.394]</td>
<td></td>
</tr>
<tr>
<td>Architecture</td>
<td>−0.028**</td>
<td>−</td>
</tr>
<tr>
<td></td>
<td>[2.233]</td>
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<tr>
<td>Design</td>
<td>−0.009</td>
<td>−</td>
</tr>
<tr>
<td></td>
<td>[−1.079]</td>
<td></td>
</tr>
<tr>
<td>Film</td>
<td>−0.109***</td>
<td>−</td>
</tr>
<tr>
<td></td>
<td>[−8.880]</td>
<td></td>
</tr>
<tr>
<td>Music</td>
<td>−0.082***</td>
<td>−</td>
</tr>
<tr>
<td></td>
<td>[−4.871]</td>
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</tr>
<tr>
<td>Publishing</td>
<td>−0.078***</td>
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<tr>
<td></td>
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<tr>
<td>Software</td>
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<td></td>
<td>[15.112]</td>
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</tr>
<tr>
<td>Libraries</td>
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<td>−</td>
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<td>[−9.886]</td>
<td></td>
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<tr>
<td>Observations</td>
<td>59,315</td>
<td>59,284</td>
</tr>
<tr>
<td>Pseudo r-squared</td>
<td>0.29</td>
<td>0.30</td>
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</table>

Notes:
Robust t statistics in square brackets; standard errors clustered at institution level; includes controls for gender, age, ethnicity, disability, work mode (part time, freelance/self employed relative to full-time employment) and region of employment.* When restricting to graduates in the creative sector only, advertising is used as reference group.

*** p < 0.01, ** p < 0.05, * p < 0.1.
* When restricting to graduates in the creative sector only, advertising is used as reference group.
with many working outside the creative industries. This highlights these graduates’ high degree of specialization but also lack of demand for digital technology skills in creative industries (if we exclude the software sector). Digital technology graduates are more likely to be embedded in non-creative industries while creative arts and humanities graduates are most likely to have specialized occupations (creative occupations in creative industries). This sectorialization of occupations and concentration of digital skills in only few creative sectors (and mainly in software) might have implications in terms of the sector’s ability to innovate and incorporate technological advances in its development (NESTA, 2008a, 2008b). At the very least, it implies that creative sectors may be less able to innovate on the technological front, but may be more innovative in terms of design and symbolic content, types of innovation that may be more closely associated with the creative arts.

While previous research in this area has highlighted the limited financial rewards and unstructured working patterns of creative graduates, graduates in digital technology experience different patterns. Digital technology graduates are paid more than creative arts graduates, but similar to other creative arts graduates, they benefit more strongly from being in a creative job (than in a non-creative one).

Results suggest a high degree of spatial concentration for both digital technology and creative arts graduates. Especially for the latter, the role of London is dominant, confirming recent research on creative industries clusters (Pratt, 2004; NESTA, 2009). Greater London and the South East of England have a leading role in the UK creative economy thanks partly to a self-reinforcing mechanism stemming from the interaction between creative universities and the creative sector. Clearly, these areas benefit from historical and infrastructural advantages in the provision of creative higher education, and these advantages are well exploited by the local creative production system.

Reflecting back on our research questions, we have shown that provision of courses in the various disciplines is not evenly distributed. Greater London and the South East attract most of the students in digital and creative disciplines. However, Yorkshire and the Humber also attract a considerable number of digital technology students. As far as first employment after graduation is concerned, Greater London and the South East also have a dominant role, providing the highest percentage of creative jobs to digital technology graduates (respectively, 24.13 per cent and 15.86 per cent) and to creative arts graduates (respectively, 36.24 per cent and 11.36 per cent).

In response to the second research question, we highlight that digital technology graduates follow specific early career paths within the creative economy. About one-third of digital technology graduates (30.4 per cent) enter the software sector. However, digital technology students clearly see the creative economy as a key sector for their employment and are more likely (if employed in a creative job) than creative arts students to state the ‘job fitted into their career plan’. We also reveal clear geographic patterns to creative jobs, as the only regions that offer more employment to digital graduates in creative jobs than non-creative jobs are London, the South East, South West, East of England and Northern Ireland.

In response to the third question, we look into the probability of digital technology graduates obtaining a creative job. Our analysis suggests that digital and creative graduates are more likely to obtain a creative job than graduates from other disciplines. Achieving a first class degree improves the chances of finding a creative job and ben-
efiting from a higher salary: however, jobs in most creative sectors (except for the more technical ones of architecture and software) pay lower salaries than other jobs. Finally, we have shown that digital technology students earn more than creative arts students and gain more by being in a creative job than other students, who on average earn more in a non-creative sector. The software sector offers them on average the greatest earnings.

Looking at the salaries of creative graduates, we confirm some of the previous observations coming from the descriptive statistics. Digital technology graduates are better paid than the rest of the creative graduates and have, generally, better working conditions. This is true whether they work within or outside the creative sector, although a creative job gives them a higher salary premium. Within creative jobs there is a clear split among sub-sectors with more technology-oriented sub-sectors doing better than the more artistic-oriented sub-sectors.

There is still little literature and data in this area of research, and the chapter has only highlighted some key issues and dimensions of this debate: further research needs to be undertaken. In particular, we need to better understand how creative industries invest in human capital and what key skills and knowledge are required in the sector. We also need greater understanding of the role of digital technology skills when adopted in embedded ways across a range of sectors. Skillset (2010) states that ‘a major gap in skills (and knowledge) evident across the Creative Industries is working with and exploiting digital technological advances (including specific software applications)’ (p. 27). This chapter has highlighted that a broader awareness of how these skills enter the creative economy is also essential in order to maximize its potential.

Moreover, the chapter should serve as a warning about considering creative industries as a ‘homogeneous entity’. There seems to be a clear separation between more technological sectors (and graduates) and more artistic ones, with the former doing relatively well in the labour market – sometimes even surpassing non-creative sectors (and graduates) – and the latter doing worse. This should be taken into account when devising policies for the creative sector as a whole, making sure that the success of the digital economy does not overshadow the difficulties (especially in terms of financial rewards) faced by the rest of the creative economy. Further research should also look comparatively at longitudinal data and career histories of graduates, both in the arts and digital technologies, to understand how their skills and knowledge are shaped by different career experiences and by engaging with different sectors of the creative economy.

More widely, this analysis raises the question of the labour force and qualifications that underpin innovative activities and new sectors in the economy. While the innovation systems literature recognizes, in general terms, that universities supply knowledge and know-how to innovators, and while it is often noted that supplying a qualified labour force can be one of universities’ key roles, this chapter begins to unveil the sectoral, geographic and industrial complexities of this role. That there exists no simple connection between creative qualifications, creative occupations and creative industries – and that these connections map unevenly onto geographic space – invites us to consider more closely the way in which this particular component of innovation systems functions.
NOTES

1. Codes include all computing sciences codes under G, all codes beginning with H6 (except H673 and codes beginning with H68 and H69) and all codes beginning with J52 and J93.

2. If we assume that full-time individuals work a minimum of 30 hours for 52 weeks and using the minimum wage as of January 2006, which was £4.25, this equates to £6630, which we rounded down to £6500.

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NESTA (2009), *The Geography of Creativity*, London: NESTA.


Part IV  Beyond agglomeration and clusters: introduction

Richard Shearmur, Christophe Carrincazeaux and David Doloreux

The introduction to this part will be brief since the rationale for thinking beyond agglomeration has been set out in the introduction to Part III. In that introduction the reasons why cities are considered to be the main generators of innovation are described, as are some reasons to qualify this idea.

Part IV comprises five chapters that provide empirical backing for the idea that innovation and creativity occur in settings that diverge from clusters and large cities. Grossetti et al. in Chapter 12 explicitly test four widely held beliefs about scientific activity. While they confirm that scientific activity is indeed geographically concentrated, they show that this concentration is not increasing, that quality research does not require a critical mass of researchers and that scientific activities are only internationalizing in a qualified way. Taken together these results, which focus on a very specific component of the innovation process, belie the idea that co-location and agglomeration are necessary for innovation to occur. If agglomeration is observed – which it is – it does not have the effect on innovation that is expected.

From a wider perspective, in Chapter 13 Gibson and Brennan-Horley show how innovation does not necessarily occur in clusters and, conversely, that innovation that emerges from clustered activity does not necessarily rest upon cluster-type interactions and dynamics, but sometimes on apparently redundant skills and machinery left over from previous rounds of development. Huber and Fitjar, in their Chapter 14, question the scale at which innovation-related interactions occur, and emphasize that localized innovation-related networks may in fact be quite limited in geographic clusters. Of course, clusters, like cities, exist and play an important role – by way of infrastructure provision, access to a qualified labour force, appropriate real-estate, ‘good address’ – but the extent to which they strengthen collaboration between local actors and generate dynamic local interactions is maybe less than usually assumed. This speaks to the distinction between static agglomeration economies and dynamic ones: Puga (2010) has suggested that the latter have not been empirically tested and verified, but are often assumed to exist.

In Chapter 15 Bain questions another commonly held belief, that is, innovation and creativity in cities require the city-centre’s ‘buzzing’ environment. By focusing on ordinary suburbs, and seeking out creators and innovators who live and work there, she shows how creative activity can take root and thrive in these locations. This chapter speaks to one of the paradoxes encountered when studying innovation that occurs outside clusters: this innovation tends to be invisible because it is not clustered. It is straightforward to identify and study a cluster of activities – clusters are easily seen when the activity is mapped, and if data are not available, local informants can often direct one to a cluster. Non-clustered activity, by virtue of being dispersed, is hidden from view: each non-clustered creator or...
innovator needs to be identified and located because, by definition, each one is relatively isolated. There can be no territorial identity or ‘terroir’-type label attributed to isolated creativity and innovation. Bain’s chapter therefore raises the possibility that isolated innovators and creators have been overlooked because they are isolated. While this is not a problem if one is examining creativity and innovation (a large proportion of all economic activity takes place in cities and clusters, as does a commensurate proportion of innovation and creativity), it is crippling if one is seeking to obtain a full understanding of innovation’s geography.

The final chapter in this part raises questions similar to those raised by Bain, but at a different scale. In Chapter 16 Isaksen and Karlsen analyse innovation in peripheral regions, and argue that it has been overlooked in the literature. They suggest that the type of innovation that occurs in peripheral regions, as well as the process of innovation itself, differ from those in cities and clusters by virtue of the organizational thinness of peripheral regions. This is a key insight, with important implications: if innovation is defined on the basis of what is observed in cities, and if innovation processes are expected to resemble those in cities, then an examination of peripheral regions will reveal no innovation – if all cats are assumed to be grey, then a white cat will not be a cat. It is only by adapting one’s understanding of innovation and of innovation processes that one will observe innovation in the periphery (Shearmur and Doloreux, 2016) – if cats are not assumed to be grey, then a white cat can also be a cat.

REFERENCES


12. Four commonly held beliefs about the geography of scientific activities

Michel Grossetti, Denis Eckert, Marion Maisonneve and Josselin Tallec

12.1 INTRODUCTION

Over the last 15 years or so scientific development policies have been implemented in various countries. Whether in Japan, France or Germany, these initiatives encourage the regrouping of universities and the functional differentiation of their roles (global, national or local, research or teaching only). These policies’ principal aim is to assess and focus the means allocated to universities (or other research institutions) based on diagnoses and assessments rooted in beliefs concerning the spatial dimension of higher education activities and research. The motivation that underlies these policies is often related to innovation and economic development – the training of qualified labour, collaboration between the private sector and universities and the registering of patents – are all understood to be at least in part related to the way academic science is organized both institutionally and spatially.

The representations that guide these policies may be regarded as ‘commonly held beliefs’ governed by ideas of an inevitable increase in hierarchical differentiation between cities and the institutions within them, of the existence of critical mass effects imposed by strengthening globalization and of the necessity of ‘competitive’ scientific activity. Such factors and global trends are believed to influence and dictate the future of national economies.

These beliefs, or myths, occasionally do rest upon theoretically informed empirical research in the social sciences, but more often than not simply rest upon commonly held ideas circulating in the scientific milieus where research and higher education policies are decided, backed by no solid empirical evidence.

In this chapter we first briefly present the field of Science Studies as it relates to geography, a nascent and still rather disorganized field. We then describe some recent work that examines more systematically the geography of scientific production, based upon bibliometric analysis. We describe our method, then discuss four commonly held beliefs that guide science and innovation policy, only one of which finds support in our data.

12.2 THE GEOGRAPHY OF SCIENCE: AN EMERGING SCIENTIFIC FIELD

The field of Science Studies has developed considerably since the early 1970s; the geography of sciences, however, is still an emerging field, offering some new perspectives in debates over previously held beliefs.
Some of the oldest geographical work on scientific activities was conducted in the field of the historical sociology of science. Joseph Ben-David began to examine the differences between national contexts in terms of scientific activities in the 1960s (Ben-David, 1968). However, it is only in recent years that historians and geographers have developed analyses rooted in Science Studies, in particular, using some of Steven Shapin’s ideas, such as: ‘if, as empirical research securely establishes, science is a local product, how does it travel with what seems to be unique efficiency?’ (Shapin, 1995, p. 307). One example is Steven J. Harris’s study on the Society of Jesus using a ‘geography of knowledge’ framework (Harris, 1998).

Another approach is illustrated by the work of David Livingstone who sought to conceptualize a ‘geography of scientific knowledge’ (Livingstone, 2003). Other authors are inspired by Immanuel Wallerstein’s work on the world-system in their own ‘geo-historical’ analyses of scholars’ spatial mobilities during their career (Taylor et al., 2008).

Gradually, in various review articles, emphasis has been placed on the need to go beyond an analysis of places and cultures and move towards a study of flows and movements. Because a new field is being established, this emphasis is accompanied by the usual rhetoric that highlights the ‘spatial turn’ in Science Studies. This view was first defended by British geographers (Livingstone, 2003; Naylor, 2005; Powell, 2007, amongst others) and more recently by French geographers (Besse, 2010; Eckert and Baron, 2013).

However, this geographic approach to Science Studies remains, for now, essentially composed of historical and qualitative analyses. Indeed, few geographers mobilize quantitative data to produce spatial analyses of academic science and its developments. French scholar Madeleine Brocard tried to in the late 1970s and early 1990s (Brocard, 1978, 1991), but her methods have not been emulated until recently.

Some notable examples are Christian Matthiessen and Annette Schwarz at the Copenhagen Institute of Geography. Their research uses bibliometric data to compare the scientific production of a series of large cities (Matthiessen and Schwarz, 1999). Heike Jöns at the University of Heidelberg has also initiated real debate on the spatial organization of scientific activities (Jöns, 2007). In the field of geography, the use of bibliometric data to study academic science remained the exception until the mid 2000s. With the increase in studies on the distribution and spatial organization of research activities (Eckert and Baron, 2013), it has only been in recent years that a handful of micro analyses of the geography of research groups have been carried out using a spatial scientometrics framework (Cuyala, 2013; Maisonobe, 2013).

Before the geography of science was considered a separate field, similar studies could be found in related scientific fields, such as the geography of innovation, which has operated within a fairly stable methodological and epistemological framework since the 1990s. It includes contributions arising mainly from economic geography and regional and industrial economy (Feldman and Massard, 2002; Autant-Bernard et al., 2007). The geography of innovation is particularly interested in the spatial dimension of links between academic research, industry and the effects of research and development (R&D) on local economic development. Such studies sometimes require the analysis of the deployment of academic research in geographic space (Sterlacchini, 2008).

Moreover, the international dimension of science has long been the subject of an abundant literature by scientists, economists, specialists in international relations (Elzinga, 2004; Weiss, 2005) and sociologists (Vinck, 1996; Gingras, 2002). A section of this
research focuses on international hierarchies and on the brain drain phenomena, brain back, academic mobility and diasporas (Meyer et al., 2001). There is also a considerable literature on scientific activities in developing or non-hegemonic countries (Gaillard et al., 1997; Losego and Arvanitis, 2008) and on the international division of scientific work (Kreimer and Lugones, 2003). It is not uncommon to find essays on research policies at the national and European levels that are framed in terms of international competition (Laredo, 2004), of the construction of a European Research Area (Hoekman et al., 2008), of the overall balance of scientific activities at the global scale of macro-regions (Glänzel et al., 2008) and of the tension between national and global science areas (Mallard et al., 2008). While there is less work at the sub-national level, certain scholars are using bibliometric data to identify the effects of de-concentrating scientific activity in Europe (Zitt et al., 1999) and China (Hong, 2008). Others are interested in the local dynamics that explain cluster constitution paths (Bozeman et al., 2007). Finally, although scientometric literature has increasingly presented results according to geographical criteria (with sometimes highly elaborated visualizations and mapping), there is only a handful of publications problematizing and questioning the role of space and territory in the dynamics of scientific activity (genesis of specialties, publication dynamics, scientific collaborations and so on).

12.3 GEOCODING DATA FOR TESTING BELIEFS

It is in this overall context of abundant but poorly organized literature, that our research group undertook in 2009 bibliometric research on the spatial organization of scientific activities. Publications, including articles, are, as we have pointed out, a useful – if imperfect – indicator of scientific production.

We have established a method to localize publications at an unprecedented level of geographical resolution: the urban level (urban agglomerations, that is, perimeters grouping cities with their suburban areas) at a global scale. We then apply this method to localize the content of a bibliographic database that is a worldwide reference, the Web of Science (WoS) of the Thomson Reuters company. The geocoded bibliographic datasets thus generated are used to test various hypotheses on the organization and spatial dynamics of scientific activity.

When we compared the results obtained after our first phase of empirical research to the beliefs that often guide science or innovation policy, we came to some surprising conclusions.

We describe our sources and methods below, before discussing four commonly held beliefs:

- Scientific activities are spatially concentrated. This is verified in our study.
- The concentration of scientific production in metropolitan areas is increasing. This is not verified.
- A critical mass of researchers is required in a given area to produce ‘quality’ research. This turns out to be false.
- Scientific activities are internationalizing. This is partly verified.
12.4 SOURCES AND METHODS FOR A GEOGRAPHICAL STUDY OF SCIENCE

The research presented in this chapter is based primarily on data from the WoS. This database includes publications (articles, reviews and letters) dating back to the 1900s in the ‘major international scientific and technological journals’ – those most cited by researchers themselves.

Since the early 2000s, the content of over 10,000 scientific journals per year has been indexed in this database. An important part of our results relate to the content of the Science Citation Index Expanded (SCIExp), which focuses on the natural sciences and technology. Among the three major indexes compiled in the WoS, SCIExp has the most extensive and reliable coverage for a dynamic analysis of publication activity worldwide.

To localize scientific activity, we achieved an almost complete geocoding (98 per cent), for selected years (1999–2001 and 2006–08), of tens of thousands of different addresses found in publications. We then group localities in what we call ‘scientific’ urban areas. The aim is to simplify and standardize the initial information in order to analyse and visualize it globally (to better understand the method, see Figure 12.1).

Extracting geographic statistics from scientific publications involves a decision on how to count publications. This decision comes after the selection of an elementary level of analysis. In our research, the preferred level of analysis is that of the scientific urban area.

Counting is an issue because most scientific publications have multiple authors. However, the authors of an article may belong to different cities and different countries. To compute the number of publications by city, we opted for a fractional count using the ‘Whole Normalized Counting’ technique (Gauffriau et al., 2008). The technique is ‘Whole’ because it takes into account not the number of addresses but the number of different urban areas that contribute to the publication (the basic unit being the metropolitan area); it is ‘Normalized’ because a fraction is attributed to each town that contributes to the publication (each urban area receives a fraction of credit for the publication that is equal to one divided by the number of cities involved).

Fractioning allowed us to simultaneously compute a range of data while maintaining their relationship with the actual number of publications worldwide (since the sum of fractions is the total number of articles published in the world). We consider this technique the most rigorous and respectful of the reality of science since it allows us to reconstruct as accurately as possible the geographical form of scientific activity discussed here (spatial groupings by urban area, region, country . . .).

To quantify the co-publications – the number of links between two spatial units – we also chose to use a whole normalized count by scientific areas. Therefore, if a publication is co-signed by \( n \) cities, each pair of cities is assigned a value \( l \) equal to:

\[
l = \frac{1}{n(n-1)} \frac{1}{2} \quad (12.1)
\]

Thus, the value of the sum of collaborative relationships equals the total number of articles co-written between two cities. Specifying the method used to count publications and collaborative links is important because results differ depending on the method chosen, especially for cities (or links between cities) located in the middle of the hierarchy.
Now that the working method has been explained, we can confront the widespread beliefs on the spatial logic of science with empirical data.

The first widespread belief we would like to address is the spatial concentration of publications in a relatively small number of cities.

12.5 CONCENTRATION

Compared to world population, scientific activity measured by the volume of publications identified in bibliometric databases is undeniably much more geographically concentrated. Indeed, in 2007, 95 per cent of scientific publications were concentrated in 912 scientific centres and 50 per cent in roughly a hundred. The majority of countries that have traditionally dominated scientific activities, especially in Europe and North America (excluding Mexico), furnish a considerable percentage of world publications (60 per cent), while their weight in the global population is much lower (roughly 15 per cent).

While this result may be partly determined by differences in language and scientific...
culture between countries, similar – though quite variable – results are found within each country (Table 12.1). If we limit our analysis to the first 11 publishing countries in the WoS, there are impressive differences. Three countries (Japan, Australia, Russia) display a sharply accentuated primacy phenomenon, with over half the scientific production originating in the top two cities. Conversely, it takes eight (India), ten (Germany) and especially 19 cities (USA) to reach the 50 per cent threshold. Other countries on the list are in an intermediate position, including France, China and the UK. The most obvious conclusion is that there is no straightforward link between the activity of a scientific system and the spatial organization, concentration or dispersal of its scientific places. The USA is, from this point of view, an extremely polycentric nation (one must accumulate the production of the first 70 US cities to reach 80 per cent of the national total of publications) while in Japan we arrive at the same level with only nine cities. In Europe, dissimilarities are just as clear. They oppose, in almost equal importance, the relatively high concentrations of the UK or France (15 cities for 80 per cent of the activity) to a more even distribution in Germany (with 24 scientific centres).

We also observe that there is no correlation between scientific dynamics and the degree of spatial concentration. Among the most concentrated countries in our table, Australia and Russia have very different dynamics. Between 2000 and 2007, Australia increased its contribution to the world total (2.1 to 2.2 per cent) while Russia’s production decreased more significantly (2.9 to 2.0 per cent) (see Table 12.3). The only obvious correlation concern is that between a rapid rise in the number of publications and geographic deconcentration over the previous 10 or 20 years (Grossetti et al., 2014; Arvanitis et al., 2012): China, Brazil, Turkey, Spain . . .

The concentration of publications in certain countries of the world is therefore associated with rather uneven concentrations of publications within their respective cities. This produces a unique distribution of publications, which cannot be reduced to that of the population.

### Table 12.1 The metropolitan concentration of science in the first 11 nations

<table>
<thead>
<tr>
<th>Number of publications in 2007*</th>
<th>50%</th>
<th>80%</th>
<th>95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>272702</td>
<td>19</td>
<td>70</td>
</tr>
<tr>
<td>China</td>
<td>90168</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>62140</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Japan</td>
<td>74429</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Germany</td>
<td>62173</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>France</td>
<td>48150</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Canada</td>
<td>37448</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Australia</td>
<td>23758</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Brazil</td>
<td>21231</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Russia</td>
<td>21834</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>India</td>
<td>30488</td>
<td>8</td>
<td>36</td>
</tr>
</tbody>
</table>

*Normalized counting (WNC), three-year moving average.

Source: SCIExp (articles, reviews, letters).
12.6 DE-CONCENTRATION

In many contemporary discourses on science, the idea of an increasing concentration of activity in a small number of cities is often taken for granted. This idea is a variation on a more general theory, which has been around for some decades in urban studies. Analyses such as those of Hall (1966), Sassen (1991), Scott (2001), Veltz (1996) and Taylor (2004) converge to underline the increasing concentration of higher functions, mainly economic, in a small number of cities – global cities. As a typical metropolitan activity, science is therefore assumed to follow the same overall scheme. Matthiessen et al. (2010), for example, seek to identify the increasing role of major scientific cities by counting publications with authors working in these centres. They compare, over the course of several years, the growth rate of cumulative publications of the top 30 publishing cities with the growth rate of all world publications. However, they do not take into account that their method includes many double counts (resulting from the fact that many publications result from collaborations between teams from different cities), which by definition cannot be the case for the global total. As we shall see, the share of collaborative articles increases over time, which distorts their calculations. Our method is systematic (geocoding of all cities, not just a few large cities) and more accurate (fractional counting, without double counts). It avoids these problems and allows a better understanding of the components and spatial dynamics of scientific activity.

A simple way to assess the degree of concentration of science is to calculate the share of world publications that can be attributed to the world’s largest scientific centres (Table 12.2). The results are clear: the trend towards de-concentration is generalized. The result is also valid throughout the WoS (see Grossetti et al., 2013).

Over a relatively short period (less than a decade), the contribution of the main world centres of scientific production has decreased. The first ten account for no more than 15 per cent of the total, losing more than two percentage points from the beginning of the decade. The general trend is the same for the leading 30, 50, 100 global cities, and even further down the rankings. This means that scientific activity is disseminating. This

<table>
<thead>
<tr>
<th>Urban areas</th>
<th>World share of publications (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000*</td>
</tr>
<tr>
<td>Top 10</td>
<td>17.39</td>
</tr>
<tr>
<td>Top 20</td>
<td>25.29</td>
</tr>
<tr>
<td>Top 30</td>
<td>30.87</td>
</tr>
<tr>
<td>Top 50</td>
<td>39.76</td>
</tr>
<tr>
<td>Top 100</td>
<td>53.55</td>
</tr>
<tr>
<td>Top 200</td>
<td>70.42</td>
</tr>
<tr>
<td>Top 300</td>
<td>80.15</td>
</tr>
</tbody>
</table>

Note: *Normalized counting (WNC), three-year moving average.
Source: SCIExp (articles, reviews, letters).
process is not new; it is slow and continuous and dates back to at least the late 1980s when the world’s top ten cities still produced 21 per cent of the total. The fact that these cities lost five points over the past 30 years clearly refutes the theory that scientific activities are increasing their concentration in large cities.

This de-concentration of publications at the global scale is accompanied by de-concentration between countries. Reports published by Thomson Reuters (Global Research Reports series, posted in 2010) on the evolution of various countries’ publications reveal a new balance between different parts of the world, with increased contributions to total scientific production from many emerging countries. The report on the USA begins with this statement: ‘The US is no longer the Colossus of Science dominating the research landscape in its production of scientific papers, that it was 30 years ago. It now shares this realm, on an increasingly equal basis, with the EU27 and the Asia-Pacific’ (Adams and Pendlebury, 2010, p. 1). By analysing citations received, the authors of Global Research Report have observed the same phenomenon of de-concentration.

Table 12.3 shows our calculations for the top publishing countries in 2007, calculations that converge seamlessly with previous analyses.

Our first observation is that there is indeed clear de-concentration at the country level. In 2000, four countries (USA, UK, Germany and Japan) produced 50 per cent of publications – 11 were required for 75 per cent of publications and 23 for 90 per cent. In 2007, five countries (USA, China, UK, Japan and Germany) produced 50 per cent of world science. It took 13 countries to reach 75 per cent of global scientific activity and 26 for 90 per cent. Although the Triad (North America, Western Europe, Japan) remains very important, the rapid rise of other Asian countries (China, Korea, Taiwan), the Middle East, India and Brazil, is striking and leads to a multipolar scientific map.

Overall, these tables summarize two major trends. The first is the increasing convergence between the Science Citation Index Expanded and researchers’ actual practices. This convergence is due to both the diversification of journals considered by the Institute of Scientific Information (Thomson Reuters) and the increasing propensity of researchers to favour journals indexed in the database.

The specific effect of this first trend is that the weight of the USA (and to a lesser extent the UK) is being gradually corrected from its original over-representation in the set of journals. Part of the US’ apparent regression is thus probably the result of the improved representation of the database.

A second trend is the increase in, and diffusion of, scientific research across the world. All indicators of this activity – the number of academic researchers, the number of universities, the number of students and so on – converge to highlight the fact that most countries are progressively equipping themselves with universities and laboratories as they develop. In simple terms, the number of publications tends to be a linear function of the production of wealth and of the financial investment made in scientific activities. Thus, socio-economic changes in the world order are apparent in the distribution of research activity. Indeed, we detect a growth in production in emerging countries, particularly in Asia; but also in Southern Europe as a result of a period of steady economic growth (Greece, Spain, Portugal). There has been a relative regression of the oldest countries present in the databases (USA, Northern and Western Europe) and a more pronounced regression of the former Soviet republics that have remained outside the European Union (Russia in particular).
Table 12.3 Evolution from 2000 to 2007 of the 30 most ‘productive’ countries

<table>
<thead>
<tr>
<th>Top publishing countries</th>
<th>World share of production (%)</th>
<th>Evolution (%2000*-%2007*)</th>
<th>Number of publications in 2007*</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>28.6</td>
<td>-3.8</td>
<td>272701.9</td>
</tr>
<tr>
<td>China</td>
<td>3.6</td>
<td>5.2</td>
<td>96474.5</td>
</tr>
<tr>
<td>Japan</td>
<td>8.8</td>
<td>-2.1</td>
<td>74428.8</td>
</tr>
<tr>
<td>Germany</td>
<td>7.1</td>
<td>-1.4</td>
<td>63690.9</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>7.4</td>
<td>-1.8</td>
<td>62139.7</td>
</tr>
<tr>
<td>France</td>
<td>5.2</td>
<td>-1.0</td>
<td>46632.3</td>
</tr>
<tr>
<td>Italy</td>
<td>3.5</td>
<td>0.1</td>
<td>39525.9</td>
</tr>
<tr>
<td>Canada</td>
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<tr>
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<td>0.2</td>
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</tr>
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<td>-0.9</td>
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<td>0.1</td>
<td>6379.7</td>
</tr>
<tr>
<td>Singapore</td>
<td>0.4</td>
<td>0.2</td>
<td>6133.6</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>0.4</td>
<td>0.1</td>
<td>5882.7</td>
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<td>Portugal</td>
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<td>5505.9</td>
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<tr>
<td>South Africa</td>
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<td>0.0</td>
<td>3943.3</td>
</tr>
</tbody>
</table>

*Note:* *Normalized counting (WNC), three-year moving average.

*Source:* SCIExp (articles, reviews, letters).
Thus, the distribution of scientific publications is clearly becoming more balanced. It is possible that the USA as well as Northern and Western European countries continue to benefit from the notoriety of their work, measured by how often they are cited. However, there are studies suggesting that not only is the concentration of publications diminishing but citations are also less concentrated than before. This fact has been established for the USA (Adams and Pendlebury, 2010) and holds true for scientific literature from all countries (Côté et al., 2016).

The de-concentration process at the country scale partly explains the de-concentration process observed at the urban level. Indeed, an analysis of a sub-group of countries (with enough urban areas belonging to the top 500) shows that 75 per cent of production growth can be explained by the country-level dynamics (Grossetti et al., 2014). However, it is theoretically possible that, once the changing geography between countries has been accounted for, we could observe a growing concentration of science in certain urban centres within a given country. To test this hypothesis, we examine the weight of top scientific urban areas in national production at various periods (Table 12.4).

It is necessary to exclude the city-state of Singapore from the 31 major urban areas in 2007. Since Singapore is both a city and a state, its production equals its national production. Among the 30 other urban areas, 24 have slowed or stagnated in terms of production rates, whereas six are on the rise. Among them, Seoul is a specific case. After a relative decrease in contributions during the 1990s (due to a policy favouring the development of Taejon), Seoul recaptured a few points over the next decade. Some American urban areas also regained a few points, but the two largest (New York and Boston) have slowed their production rates, though the amplitude is minimal. Finally, Berlin is a particular case because it became a capital city during the 1990s: it has also been affected by Eastern Germany’s catch-up dynamics following reunification.

Among urban areas that have reduced their relative weight, Beijing, Paris, Moscow, Madrid and Taipei are the most visible. While Beijing, Taipei and Madrid belong to countries where scientific production has grown substantially over the last decade, the number of each city’s publications has increased more slowly than that of other cities in their country. By contrast, Paris and Moscow are capitals in countries that are not only losing weight at the global level but also undergoing a de-centralization process. There is also wide amplitude of variation within countries. Though China, France, Spain, Russia, the UK (and even South Korea over the last 20 years) are engaged in a process of reinforcing secondary cities, other countries (USA, Japan) are more stable. As a consequence, the map of their scientific activity is similarly stable over the period under study. Italy and Germany require a more detailed analysis. Their capitals were not in a hegemonic position at the beginning of the period, but the evolutions we observe are the result of distinct trends.

Thus, we must bear in mind that the de-concentration observed within countries is not simply a scaled down version of the global between-country trend. However, most of the top urban areas are losing scientific weight within their own country.
There exists ample literature describing research policies premised upon ‘the critical mass theory’. The metaphor refers to the mass of radioactive materials needed to trigger a nuclear reaction. Applied to research activities, quality of research is thought to require a critical mass, or a high enough density, of researchers located in a single institution, city or region. This concept is based on the belief that there exists a correlation between the number of researchers in a given context and the chances for them to interact. When
a sufficient number of interactions are possible, scholars are stimulated to further their research exponentially. As early as 1991, geographer Madeleine Brocard noticed that

the idea of a ‘scientific pole of excellence’ is often used in discourses dealing with public research, since it is necessary to allocate state funds . . . It is based on the idea that there exist threshold effects. Beyond a certain number of researchers in a given discipline, the concentration of intellectual minds and equipment should ignite the spark. However, this has yet to be proven . . . . (Brocard, 1991, p. 49, translated from French).

However, whereas it is possible to precisely compute critical mass in physics, this is of course not so in social activities, be they research activities or other.

Empirical studies have shown that there is no link between the number of researchers gathered in the same area and the mean number of articles published by each researcher of said area (Bonaccorsi and Daraio, 2005). Jonathan Adams and Simon Thomson came to the same conclusion when working for the group University Alliance in response to the excellence policy implemented in Britain (Kenna and Berche, 2011; University Alliance, 2011). Their studies agree that the ‘critical mass theory’ is nothing more than a widespread belief, with no empirical basis. In reality, the number of publications measured in an area is linearly related to the number of researchers working inside the area. This is determined by the geographical diffusion of higher education services and to national and local research policy (Grossetti et al., 2002).

To further explore this idea, we exploited our corpus of publication data and focused on the top 20 French urban areas (in terms of the number of publications). Our goal was to determine whether or not the number of publications measured in these cities relates to other variables (number of inhabitants, number of students and so on). The following is the best model we found (see appendix).

*Variable to be explained:* \( \log (\text{number of publications computed with fractional counts}) \).

*Independent (explanatory) variables:* \( \log (\text{number of CNRS researchers in science and engineering}) + \log (\text{number of higher education teachers}) + \log (\text{number of engineers}) \).

This model offers a fairly accurate prediction since the multiple correlation coefficient \( R^2 \), which gives a good idea of the share of variation that can be explained by the model, reaches 95 per cent.

A historical example further supports our claim. If we were to calculate the number of researchers in theoretical physics working in Bern in 1905, we would have only one: Albert Einstein. His relative solitude does not seem to have had any ill effects on his performance. The example of Einstein is actually very instructive. He was isolated in his institution (which was not devoted to theoretical physics) but entertained correspondence with many specialists in his field and was therefore embedded in a wide scientific network.

Finally, we can look at small scientific sites, which are numerous in France (in Table 12.5 they are listed under ‘Other regional capitals’ and ‘Departmental capitals with universities’) and see that their publishing rates are non-negligible and growing.

These counts indicate that the share of Parisian production is dropping, while other cities are increasing their publication rates, even the smallest or those that have just recently been equipped with a higher education institution.

To summarize, concentration does not affect the individual productivity of researchers. ‘Critical mass’ does not exist in this context. Current research on citations shows that large
Commonly held beliefs about the geography of scientific activities

12.8 INTERNATIONALIZATION

The fourth and last widespread belief that underpins the discourse on the spatial organization of scientific activities is the idea that there exists a trend towards the internationalization of collaborations and towards the decreasing relevance of national contexts: in an increasingly globalized scientific system, it is assumed that national systems are losing their relevance. This hypothesis is notably defended by a US specialist of science policies, Caroline Wagner (2008).

Our approach allows us to study collaboration networks thanks to co-authorship data and to thereby test this hypothesis at the urban area level. Does the development of globalized collaboration networks come at the expense of national networks? Or do results confound expectations, upholding the idea that, for the most part, collaborations occur within national frameworks and within sets of similar countries like Scandinavia (Frame and Carpenter, 1979; Schubert and Braun, 1990; Luukkonen et al., 1992; Zitt et al., 2000; Glänzel, 2001; Hoekman et al., 2008)?

Results presented in Table 12.6 answer these questions. The first notable observation is the large proportion of publications signed by teams from only one urban area. They represent two-thirds of the total, even though this proportion decreased during the period under study. We also see that the proportion of national collaborations increased at the same pace as international collaborations, both evolutions occurring at the expense of within-city publications. Contrary to the belief that international collaborations are rapidly becoming the norm, scientists do not appear to have participated in additional international collaborations during the previous decade. The growth of international collaborations is no more rapid than that of within-country inter-urban collaborations, and is therefore just a reflection of worldwide growth in inter-urban collaborations, be they from the same country or not. Taking into account the linear relation between a country’s de-concentration rate and its internationalization rate, we can surmise that the phenomenon differs from one country to another. Countries where there is a tendency to

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
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<td>Paris</td>
<td>46.3</td>
<td>43.8</td>
<td>37.6</td>
<td>34.9</td>
</tr>
<tr>
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<td>7.2</td>
<td>7.3</td>
</tr>
<tr>
<td>Departmental capitals with universities</td>
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<td>6.6</td>
<td>8.1</td>
<td>9.3</td>
</tr>
<tr>
<td>Departmental capitals without universities</td>
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<td>0.08</td>
<td>0.16</td>
<td>0.25</td>
</tr>
<tr>
<td>Other cities</td>
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<td>2.4</td>
<td>3.2</td>
<td>3.7</td>
</tr>
<tr>
<td>Total</td>
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### Table 12.6  Types of collaborations and their evolution

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<td>17.3</td>
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<tr>
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<table>
<thead>
<tr>
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<td>Several cities in the same country</td>
<td>18.4</td>
<td>20.1</td>
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<td>315503.7</td>
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<table>
<thead>
<tr>
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<td>6.4</td>
</tr>
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<td>100.0</td>
</tr>
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<tr>
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<td>30.3</td>
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<tr>
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<td>15.0</td>
</tr>
<tr>
<td>Several cities in the same country</td>
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<td>12.3</td>
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<tr>
<td>Several cities, several countries</td>
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<td>42.4</td>
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<tr>
<td>Total (%)</td>
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<td>100.0</td>
</tr>
<tr>
<td>Total number of articles, reviews, letters</td>
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<table>
<thead>
<tr>
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</thead>
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<td>45.1</td>
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<tr>
<td>Several cities in the same country</td>
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</tr>
<tr>
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<td>20.0</td>
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<tr>
<td>Total (%)</td>
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<td>100.0</td>
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<tr>
<td>Total number of articles, reviews, letters</td>
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<table>
<thead>
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</thead>
<tbody>
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<td>30.9</td>
</tr>
<tr>
<td>One city and several addresses</td>
<td>17.0</td>
<td>23.1</td>
</tr>
<tr>
<td>Several cities in the same country</td>
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<td>21.1</td>
</tr>
<tr>
<td>Several cities, several countries</td>
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<td>24.9</td>
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<td>Total (%)</td>
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<td>100.0</td>
</tr>
<tr>
<td>Total number of articles, reviews, letters</td>
<td>10638.7</td>
<td>24606.7</td>
</tr>
</tbody>
</table>

**Note:** *Normalized counting (WNC), three-year moving average.

**Source:** SCI Exp.
Commonly held beliefs about the geography of scientific activities

nationalize (to develop inter-urban collaborations within national boundaries) are those in which the de-concentration process has been the most intense during the last decade, that is, China, South Korea, Brazil and Spain.

In comparison, major cities with a growing relative proportion of international collaborations are found in the USA and the UK; countries which have benefited from better coverage in the WoS database in the past. Given the fact that local scientific research is being produced by an increasing number of scholars and institutions at the world level, traditional areas of activity are interacting with new places of production whether at the level of a nation, a macro-region or the world.

12.9 CONCLUSION

Empirical studies of the spatial organization of scientific activities are still rare. In this chapter we have presented certain results that relate to four commonly held beliefs often referred to and used as arguments in debates about science and innovation policy. These beliefs all revolve around the spatial concentration of scientific activities (its current state, its evolution, its effect on the productivity of researchers and its effect on collaboration patterns).

Our results show that these common beliefs are often wrong. Though scientific activity is indeed highly centralized, the current trend is towards diversification and de-concentration rather than a reinforcement of the most important centres. The spatial concentration of researchers has no specific effect on their individual productivity. National contexts are not fading; they are merely combining with the growth of international collaborations in a global context characterized by the decline of publications signed by a single person or a single team.

Our conclusions should be seen as a starting point in an insufficiently developed field. Much remains to be done, such as the study of variations by disciplines or that taking into account of citations and collaboration networks. We would like to make a plea here for the development of a distinct research field that would focus on the spatial analysis of scientific activities and collectives. We hope that an increase in such analyses will uncover solid trends that could enlighten public policy, which is still too often based on unfounded beliefs.

NOTE

1. All these variables comply with a log-normal distribution, the log function allows us to return to normal laws and thereby improve the quality of the model.

REFERENCES


APPENDIX

To explore the idea that the number of publications measured in an area is linearly related to the number of researchers working inside the area, we explore our corpus of publication data and focus on the top 20 French urban areas (in terms of the number of publications). Our goal is to determine whether or not the number of publications measured in these cities relates to other variables. Tables 12A.1, 12A.2 and 12A.3 present the best model.

**Table 12A.1  Model summary**

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R²</th>
<th>Adjusted R²</th>
<th>Standard error of estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.978</td>
<td>0.956</td>
<td>0.947</td>
<td>0.224</td>
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</tbody>
</table>

**Table 12A.2  ANOVA**

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of squares</th>
<th>ddl</th>
<th>Mean square</th>
<th>D</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
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<td>3</td>
<td>5.475</td>
<td>108.743</td>
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<tr>
<td>Residual</td>
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<td>15</td>
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<tr>
<td>Total</td>
<td>17.180</td>
<td>18</td>
<td></td>
<td></td>
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</table>

**Table 12A.3  Coefficients**

<table>
<thead>
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<th>Standardized coefficient</th>
<th>t</th>
<th>Sig.</th>
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<tr>
<td></td>
<td>A</td>
<td>Standard error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>1 (Constant)</td>
<td>0.726</td>
<td>0.465</td>
<td>1.561</td>
<td>0.139</td>
</tr>
<tr>
<td>Log (researchers)</td>
<td>0.250</td>
<td>0.047</td>
<td>0.429</td>
<td>5.276</td>
</tr>
<tr>
<td>Log (teachers)</td>
<td>0.357</td>
<td>0.088</td>
<td>0.392</td>
<td>4.061</td>
</tr>
<tr>
<td>Log (engineers)</td>
<td>0.283</td>
<td>0.123</td>
<td>0.272</td>
<td>2.306</td>
</tr>
</tbody>
</table>

Note: Dependent variable: log (number of publications computed with fractional counts). Independent variables: log (number of CNRS researchers in science and engineering), log (number of higher education teachers), log (number of engineers).
13. Putting the boot into creative cluster theory

Chris Gibson and Chris Brennan-Horley

13.1 INTRODUCTION

Geographical clusters have become axiomatic in theories of creativity and innovation. In industries where innovation is central, the tendency – it is said – is for firms to spatially agglomerate in specific places: typically, sizeable urban complexes with sufficient infrastructure and technology (for example, telecommunications), highly educated workforces and access to venture capital for research and development (R&D). Clustering is advantageous to firms as it promotes greater levels of innovation due to physical proximity and the networked relationships that are unleashed: proximate firms learn and feed off each other, share novel insights, subcontract and engage in trading tacit knowledge via dense webs of untraded interdependencies (Porter, 2003). Firms gravitate geographically.

Such axioms of cluster dynamics have congealed to the point where they have become important ‘truths’ that underpin a whole industry of innovation management and planning (Shearmur, 2015). In the process, cluster theory has become a perennial feature in off-the-shelf urban development policy prescriptions rolled out across a countless number of municipalities worldwide. Urban development schemes predicated on spatially proximate networks have been actively promoted as a governance tool for economic development, attempting to provide a degree of spatial fixity to an elusive, yet economically important, set of innovation activities (Mommaas, 2004; Pratt, 2004). Such circulating ideas about geographical clustering manifest spatially in the built environment in proliferating variations on the theme: creativity hubs, high-tech industry clusters, ‘edge city’ office parks and innovation campuses (such as that built by our own university) – often at great expense and with significant public subsidy.

This chapter seeks to provide a critique of this state of affairs, aimed at sobering the degree of enthusiasm to rush to clusters as the pre-eminent policy solution. The critique is organized in two sections. First, in Section 13.2 we revisit key thinkers in economic geography who theorized agglomerating tendencies as a key dynamic within a broader geography of economic activity that encompasses centripetal and centrifugal geographic forces. Second, in Section 13.3 we illustrate the roles that underlying geography and history play in shaping the possibilities for agglomeration and dispersal of innovation activities. More than mere externalities, such factors – that include culture, social structure, urban built form, physical distance, governance arrangements and degree of state provision, geopolitical circumstances and demographic characteristics – are fundamental to how innovation activities are empirically observed (and might be fostered). Such factors shape the conditions of possibility upon which multiple-scaled economic geographies evolve.

Two empirical examples from our previous work on the geography of a particular sector of innovation activities – the creative industries – are briefly revisited in Section 13.3 to illustrate the argument. The first is a creative industries mapping project that
sought to empirically document economic activity in Darwin, Australia, a small, highly suburbanized and physically remote city not normally associated with big city innovation (Brennan-Horley, 2010; Gibson et al., 2010). Playing with a pun from this chapter’s somewhat incendiary title, the second example is of bootmaking in El Paso, Texas, which was the focus of another extended economic geographical analysis (Gibson, 2016). Drawing inspiration from recent critical, and grounded, work in evolutionary economic geography (MacKinnon et al., 2009; Hassink et al., 2014), the El Paso research was attuned to deeper run, geographically contingent and cumulative-causal processes that shape present possibilities (Rantisi et al., 2006; Weller, 2007). A key focus was on how the materiality of labour process and product design unfurl in time and space (cf. Müller et al., 2009; Bryson and Ronayne, 2014), illuminating how key sites of expert knowledge are consolidated (Weller, 2007). In both cases what appeared initially as exemplary cases of clustering forces at work within creative industries were revealed through empirical analysis as more complex interplays of centripetal and centrifugal forces, with innovation held in tension with long-run historical and geographical inheritances.

We are keen to emphasize that, despite our cheeky chapter title, the chapter does not seek to entirely discredit theories of clustering dynamics. Within our empirical work we too observe clustering forces at work. Rather, in this chapter we seek to situate clustering dynamics within broader forces and inheritances that are invisible or frequently overlooked in the rush to embrace simplistic urban development policy solutions (cf. Shearmur, 2015). Nor does the chapter provide an alternative overarching theory or explanation for the geography of innovation – that would be well beyond the scope of what is possible here. Instead, it is with the manner in which a simplistic formula has become axiomatic, and the focus of rather uncreative policy work, that we take task. The great risk is that place-specific inheritances and counter-geographical tendencies are overlooked in the rush to prescribe solutions. Exploring grounded examples such as those encountered in this chapter illustrate the broader context of economic geographical dynamics – and limits to cluster theory.

13.2 FROM POLITICAL ECONOMIES OF INNOVATION TO CLUSTER POLICIES

In the innovation management world it is often forgotten that cluster thinking had its genesis in a particular school of urban and regional economic geography that had rather different antecedent aspirations. Scholars such as Allen J. Scott (1988), Susan Christopherson and Michael Storper (Christopherson and Storper, 1986) were prominent early figures and critics. The intent was not to give birth to a new ‘brand’ of neo-liberal, proto-capitalist policy-making that promotes urban development projects within spatially confined quarters. Economic geographers were instead interested in innovation and related cultural/creative industries from a specific precursory intellectual space. They had spent the better part of the 1980s and 1990s debating the rise of post-Fordism and so-called ‘flexible accumulation’ and were seeking to capture analytical insights that explained the cultural embeddedness of capitalist activities (see, for example, Peet, 2000; Jessop, 2010) and the simultaneous emergence of new spatial configurations in production (there was, for instance, a conscious disposition towards examining ‘new spaces
of production’ in regions other than the fading rust belts, such as the ‘third Italy’ and southern California).

Hence, for Scott (1996), the structure and dynamics of modern production systems fuelled massive agglomerations of capital and labour – Marshallian industrial districts that were effectively the basic building blocks of the large metropolises that were in turn the motors of the global economy. The city-region became ‘a nexus of production relationships and associated social infrastructures’ (Scott, 2004, p. 486). On the one hand, firms that depended on constant innovation were vertically disintegrated, and relied on dense inter-firm transactions. The size, structure and interdependent relationships between firms encouraged spatial agglomeration in particular districts, usually in large cities. On the other hand, innovation was unstable, unpredictable and continually evolving – meaning that ‘frequent access to a large variety of relevant skills is paramount’ (Scott, 1999, p. 812), again encouraging spatial agglomeration.

A special priority was placed on proximity and face-to-face interactions (Watson, 2008). Proximity was important because it underpinned the emergence of what Bourdieu (1993) describes as a ‘creative field’, a complex of innovation dynamics dependent on an ‘industrial atmosphere’ (in the Marshallian sense) present in specific urban milieus (Scott, 1999). As Leadbeater and Oakley (1999, p. 14) argued in the context of creative innovation,

Cultural industries are people intensive rather than capital intensive . . . Cultural entrepreneurs within a city or region tend to be densely interconnected. Cultural entrepreneurs, who often work within networks of collaborators within cities, are a good example of the economies of proximity. They thrive on easy access to local, tacit know-how – a style, a look, a sound – which is not accessible globally.

The concept of networking is regularly championed, with the driving force behind successful creative work said to be reliance on cultural intermediaries and interpersonal relations bound up in degrees of geographic proximity (Wittel, 2001). With little surprise, the bulk of subsequent research has focused on agglomerations or clusters of activity in districts of major Western cities (for example, Bathelt and Gräf, 2008; Reimer et al., 2008; Watson, 2008), where accumulations of interpersonal and firm linkages are most visibly dense.

Importantly, early proponents were interested in the entirety and complexity of economic relations across geographic space – not just within the cluster – and within the entire production and labour process, rather than just the ‘immaterial’ innovation stages (Pratt, 2008). The task was to update knowledge of the urban and regional dynamics of capitalism more generally – within an overarching paradigm that sought to disentangle the dynamics of uneven development.

Nevertheless, when the more neoliberalized policy fashion for clusters (and its close cousin, creative economy) gained momentum in the late 1990s and early 2000s (see Gibson and Klocker, 2004 for fuller critique), this kind of regional economic geography model provided an unintended scholarly knowledge base. Theories of urban and regional agglomeration offered an explanation for the growth dynamics underpinning ostensibly new, higher-value, sectors. Via a loose and decentralized knowledge-policy-advocacy assemblage (that included celebrity ‘experts’ such as Michael Porter and Richard Florida, who themselves circulated and profited from the popularity of innovation/creativity
Handbook on the geographies of innovation

clusters) economic imaginaries about clustering tendencies promulgated, and were shorn of much of their political economic grounding (cf. Jessop, 2010). Instead, they were welded more firmly among the consultancy think tank set to an agenda of looking to market forces and the urban development/building and construction sectors to generate economic activity in spatially contained precincts. Such precincts were often named and branded as innovation hubs or creative clusters in new greenfield developments or in redeveloped dilapidated ex-industrial neighbourhoods of warehouses (Bell and Jayne, 2004). In many cases, they were less an outcome of strong evidence-based policy-making than a part of ‘transition fantasies’ (Lovering, 2001) entertained by city boosters and developers, operating within an increasingly entrepreneurial mode of urban governance to solve problems of disinvestment through creativity and innovation. Cluster dynamics, it seemed, could be cultivated: build a flashy new precinct, and they will come.

13.3 OTHER GEOGRAPHIES AND HISTORIES OF INNOVATION

One effect of this mass of academic work and policy-making has been to shape a particular set of assumptions about where innovation is located, where it is likely to emerge and why (Brennan-Horley and Gibson, 2009; Shearmur, 2015). It would appear from the literature alone that firms have a predilection towards sizeable cities – ex-industrial powerhouses or cities of global stature – and towards particular northern hemisphere cities in the industrialized West.

And yet, as an increasing number of scholars are drawn to point out, this picture is at best very partial (Gibson, 2012; Bain, 2013). Cluster theory almost unashamedly promotes an urban bias. And, as Shearmur (2015, p.1) succinctly puts it, the urban assumption underpinning cluster theory flies in the face of empirical work, ‘showing that innovation occurs in peripheral regions, that openness – at least when measured by the variety and type of external contacts – is not necessarily higher in cities, and that firm-level innovativeness is only weakly associated with location across the metropolitan to peripheral small town spectrum’. Exploring geographies of creativity and innovation beyond urban clusters brings into question a range of assumptions and critical issues for the wider study of economic geography.

Prominent among those countering the preference to examine local, network-based, urban clusters have been economic geographies of global production networks, the ‘organizational arrangement comprising interconnected economic and non-economic actors coordinated by a global lead firm and producing goods and services across multiple geographic locations for worldwide markets’ (Yeung and Coe, 2015, p.32). Such studies, and associated critiques, draw attention to the manner in which agglomerations of firms in urban regions interact with wider forces that simultaneously disperse mobile capital and divisions of labour (Weller, 2014).

A second issue relates to the importance of proximity in urban milieus. If proximity is vital to the creative field, to enabling face-to-face interactions and tacit knowledge retention, and for reducing risk within volatile markets for innovative products, what challenges does remoteness and smallness generate – the gravity of physical distance?

A growing tide of researchers (including Allen Scott himself, writing more recently
about the English Lake District – see Scott, 2010) have sought to explore how innovation and creative industries emerge instead from small, suburban, rural and remote places and are implicated in a range of social, economic and technical transformations peculiar to those localities (Felton et al., 2010; Bain, 2013). Innovation has other geographies that overlay and unsettle the archetypal spatially confined cluster.

13.3.1 Beyond Proximity: Insights from Darwin, Australia

In our empirical work in Darwin, Australia (see Brennan-Horley and Gibson, 2009; Gibson et al., 2010), we observed what, on the surface of things, presented as a typical inner-city concentration of creativity and innovation. Over a hundred firms and creative practitioners participated in the project, which involved interviews and a mapping exercise. The bulk of these firms and solo operators worked from offices and bases in Darwin’s central business district or nearby established inner-city suburbs.

Yet, rather than rush to merely confirm the existence of cluster dynamics at work, we were also concerned with situating innovation and creative activities in wider networks of suburban, ex-urban and national and international linkages. Accompanying such wider geographies were the sheer challenges of remoteness – for Darwin is 15 hours’ drive to the nearest substantial town (Alice Springs, with only 25,000 people) and 3000 kilometres to the nearest state capital city (Adelaide). Flights from other capital cities take several hours; in driving out of the city one quickly enters a brutal tropical savannah landscape: wide flooded coastal plains dominated by *Melaleuca* forests, swampy tidal mangrove forests and crocodile-infested inlets, and spiky *Pandanus*.

Remoteness presented immediate issues such as the costs associated with flying in people for meetings, and more complex issues such as the difficulties of accessing key industry gatekeepers. Remoteness ‘means limited types of creative making; wariness of newcomers and new ideas; the loss of young people; limited access to business expertise, production services and training; lack of cultural stimulation; and high transport costs’ (Andersen, 2010, p. 71).

Moreover, in the Darwin context of remoteness, a highly suburban built environment and challenging location (in the tropics, where repeated cyclones have destroyed city infrastructure) renders the notion of the singular firm location or workplace outdated. Increasingly, work is organized around solo operators, long-distance commuting (and accompanying enormous accumulation of flight miles) and highly mobile small-to-medium firms where activities are themselves dispersed, often across vast distances – to the point where the stable, singular workplace fades from memory. And yet, across a range of sectors – notably architecture, software development, music and design – the degree of innovation among such firms was very high. Indeed, remoteness and the challenges of an extreme biophysical environment arguably fostered distinctive innovations not possible elsewhere – such as in the development of new vernacular architectural styles and techniques.

From this research experience we became mindful of a disjuncture, common to economic geographic analysis of urban and regional clusters, between how centripetal forces are understood – as embedded in networks, both spatial and relational – and the realities of how they are represented cartographically in research. Analyses of innovation clusters based on cartographically mapping creative workers or firms with high R&D inputs perpetuate ideas of inner-city dominance – simple urban maps with dots representing...
firm locations, with networks and connections between actors in inner-city clusters inferred rather than evidentially revealed (Kong, 2009). Such maps have proliferated through academic papers, consultancy reports and PhD theses, with scant critical reflection on the underlying assumptions and cartographic methods that give rise to particular spatial depictions. In a policy sense, such cluster maps simply reinforce metropolitan dominance, and lead to the potentially false identification of inner-city clusters as key locations in the innovation value chain, masking the role of other locations and mobilities in the day-to-day workflows of innovative activities. At fault is that firm location and employment statistics are premised on the notion of the singular workplace – the geocoded street address.

Had we produced the kind of map that typically features in cluster studies, placing dots to indicate the location of each of Darwin’s firms/actors, we would have created the impression of exactly the kinds of proximity effects that underpin cluster theory. Yet our subsequent topological mapping of creative working lives in Darwin (Brennan-Horley, 2010) revealed that such static point data cannot encapsulate working patterns for innovators and creative practitioners whose workdays (or nights) are predicated on fluidity. The day-to-day movements of a musician are a case in point: managing affairs from a home office, rehearsing with various groups in different studios, recording or performing in different spaces again. Each space remains important to that musician’s creative work (Watson, 2014). However, if and when musicians appear in firm location or census data (and there is much evidence to suggest that census and firm statistics miss musicians altogether), only one site can be accommodated: whichever site they register as the business street or postal address, or indicate as their major place of employment during census administration. Such fluidities are exacerbated in the many small and medium places remote from major metropolitan complexes – such as Darwin – where long-distance commuting, subcontracting and telecommuting have become much more normal.

In the Darwin study, we explored a topological approach to mapping innovation that uses the connections between places for inferring how creative work is situated in the city and beyond, rather than relying on topographical comparisons between contiguous spatial units. In an empirical study of topologies of creative work in Darwin, 101 interview participants located 472 work locations. Some 93 of these were ‘major’ workplaces (generally the firm/solo operator’s postal or street address – but not always), with the remaining 379 locations additional spaces of work interaction across the city and beyond. Such workplaces could perform any number of roles, from the utilitarian, such as sites of supply, to more important roles as sites of exchange, networking or performance.

Resulting network topology maps (Figures 13.1–13.3) provide a strong evidential base for repositioning the suburbs, and ex-urban areas, as much more than simply a dormitory location for inner-city workers. Instead, the magnitude of networked relationships that involve the suburbs and beyond implies that mobility is vital to the functioning of the innovation economy – not just centripetal flows. Such findings are of special significance in regional or remote locations, places of low population or low density, where opportunities for networking or clustered facilities and infrastructure are scarce and distributed over larger areas. Innovation practitioners across the city are still networking and sharing resources, but in places like Darwin they are forced to make do with less, to fan out and source materials and connections and utilize spaces that are on offer regardless of their location, rather than working and remaining in distinct spatial clusters or milieus.
Note: Lines visualize networks of movement between the city centre and outer suburban spaces of work. Numbers in parentheses equal the count of major workplaces within the statistical local area.


Figure 13.1 Gross creative flows between workspaces, Darwin Australia
Note: Numbers in parentheses equal the count of major workplaces within the SLA.


Figure 13.2  Gross creative flows between workspaces outside the central city cluster
Figure 13.3  Remote community networks: places of work cited in interviews with creative workers, as percentage of total number of places of work outside Darwin city

Source: Gibson et al. (2010), p. 33.
13.3.2 Historical Inheritances: Insights from El Paso, Texas

If the Darwin example encourages us to move beyond the spatially bounded cluster in our conception of geographies of innovation, then our second example, from El Paso, Texas, invites us to break beyond the boundaries of the present, to explore deeper historical legacies that give rise to situations that, on the surface, appear to fit the criteria of urban creative/innovation clusters.

This second case study was of bootmaking – and specifically cowboy bootmaking, a distinctive design format for footwear with origins in the American colonial frontier that was mythologized and popularized in film, music and television westerns in the twentieth century. Industrially, cowboy bootmaking has long been associated with Texas, and was once the feature of a mass manufacturing complex centred on El Paso, and to a lesser extent other urban centres including Fort Worth, San Antonio, San Angelo and Nocona (Gibson, 2016). Since the peak of mass manufacturing in the 1970s, production has steadily headed offshore to locations where automation, lax environmental standards and highly exploitative labour conditions lower costs of the factors of production. Bucking the trend, however, El Paso has evolved what on the surface of things (for example, through a simple map of firm locations) appears to be a distinctive contemporary bootmaking cluster, centred on its older warehouse and manufacturing districts to the immediate east of its downtown area. El Paso bootmaking firms combine historical inheritance of earlier industrial techniques and labour skill, overlaid with new innovation and creative industry logics, such as use of the internet and e-commerce, high design input and fashion industry connections. These factors, combined with that city’s borderland location, Wild West history and reputation, and remaining skilled workers from an earlier era of mass manufacturing, enable boots to be now marketed as ‘crafted’ and ‘authentic’ – high-value customized products in an era of cultural capitalism.

In El Paso there is plenty of observable evidence of a contemporary innovation cluster: small bootmaking firms are located in a fairly close geographic range, proximate to key leather suppliers, and make high-end boots. New sources of value have stemmed from diversification, specialization and innovation – for some through use of information and communications technology (ICT), for others through networks of social links to the Los Angeles/Hollywood film and music industry scenes. Others have retrieved vintage designs and forged new links with high-end fashion retailers nationally.

Pertinent here is the degree to which, beyond the typical signs of Marshallian agglomeration present, are important technical and social inheritances from earlier phases of capitalist activity. In this contemporary craft-based and customized form of manufacturing, it is important that the boots are seen as made the old-fashioned way. Such boots are marketed as living remnants of a small town, pre-modern, pre-Fordist manufacturing technique, things made well by human hands. Workshops purposely hold onto archaic production techniques such as hand-pegging soles and personalizing lasts (foot moulds) that are kept on file for future reference. Retention of labour process throughout successive generations of manufacturing formed a vital historical inheritance that undergirds the contemporary cluster. For bootmaking this has included high degrees of manual, but skilled, labour in leather cutting, stitching and inlay and tooling work – skills that reside in that city’s Mexican community as a consequence of consecutive waves of cross-border migra-
tion (that in turn stemmed from the city’s unique – and often contentious – borderland location).

In a manner that inverts theories of innovation, bootmaking firms have also held onto, revived and inherited old machinery from both the artisanal and mass manufacturing eras – not just because of its intrinsic authenticity but because skilled workers know how to use and maintain it, and it is simply better quality equipment. Such machinery became surplus to requirements with the contraction of mass manufacture, and was readily available at low cost (or in some cases was ‘handed down’ gratis) to those bootmakers who persisted and remained in El Paso as small operators. Among the skills cherished by workshop owners are the abilities of craftspeople to also service and fix the old machines, most of which are pre-World War II vintage.

Unlike in the factory era, where firms sought to improve efficiencies of the production line, with standardized lines and sizes, and eliminating dependence on skilled labour, in the new craft era workshops are run by people who view themselves as ‘creative’ people with artisanal values, seeking to carve a living from a personal ‘passion’ through innovative use of new marketing techniques. While ostensibly manufacturing firms with small runs of craft-based physical production, they have increasingly embraced selected logics of creative work. They emphasize bespoke customization, creativity and originality in design and the central role of the bootmaker as artisan/genius (cf. Sennett, 2008). Because volume and subsequent markets are limited, emphasis is placed on high-cost materials, rare labour techniques (such as tooling, an ornate leather carving technique, which is the most highly paid leather craft) and design intensity. Such qualities were not created through contemporary cluster dynamics as such, but through lock-ins in labour process and skill that the region inherited from an earlier era of mass manufacturing.

Further complicating a surface reading of the El Paso case as a new innovation/creative cluster were the observed extra-local dynamics shaping the industry: these included expanding new markets for high-end boots among collectors and subcultural connoisseurs. Firms now use e-commerce to appeal to affluent customers internationally who order custom-made boots online, or in some cases, fly in to El Paso specifically to be measured up for custom boots. Meanwhile, connections to global sourcing networks for high-grade leather are increasingly complex, involving some firms sourcing animal skins directly by sending representatives around the world to visit concentrations of tanneries elsewhere. (Almost all the skins used in high-end bootmaking are international in origin, with exotic alligator and snake skins sourced in Brazil and Asia, ostrich from South Africa, calf and kangaroo leathers from France and Australia, via Italy.) Adding to the degree of historical embeddedness, these latter trading routes for leather were themselves forged in much earlier mass manufacturing eras where skills in tanning concentrated historically. The imprint of history is more significant in shaping a contemporary concentration of firms than the need for those firms to locate proximally for subcontracting or networking purposes.

The case of El Paso supports the overall argument that forms of innovation must be understood as having evolved in place because of a complex mix of legacies, material inheritances, underlying geographical conditions, waves of investment and negotiations between firms and workers over labour process. In El Paso, bootmaking has transitioned from mass manufacture to craft-based cultural capitalism, and has been repositioned as...
creative and innovative rather than routine. Yet the basic commodity type form, design template, construction methods and tooling and machinery are largely unchanged.

13.4 CONCLUSIONS: WHITHER URBAN CLUSTERS?

The degree to which cluster theory provides a sound base for urban development policy-making remains an open empirical question (Shearmur, 2015). Revisiting the ideas of early advocates of agglomeration, we are reminded that all the while there are other geographies at work – geographies that connect clusters to centrifugal forces of trade and mobile capital that in turn shape the broader landscape of uneven development upon which putative urban clusters emerge. From our Darwin work, we also witness that those centrifugal forces shape other geographies of innovation beyond big urban complexes – geographies that include fluid workflows and dispersed workspaces and networks, and more complex relations and geographies of activities both within urban milieus and beyond.

Meanwhile, as the El Paso case attests, tracing the economic geography of creativity requires greater recognition of deeper, place-specific inheritances – and understanding of the manner in which contemporary dynamics intersect with uneven geographies of growth and decline from earlier eras (Massey, 1984). Histories of manual labour, skills transfer, product design and trade in key materials influence present and future possibilities, and bestow select cities and regions with traits that provide the means for later reorientation around innovation/creativity logics. Apparently redundant skills, production methods, machinery and supplies can linger and provide future opportunities. Nevertheless, this may only occur in certain places, and for certain forms of production – where mobile capital is targeted, and where strong cultural place associations, technical path dependencies and labour inheritances are present. The rush to translate cluster theories into policy solutions for urban places overlooks the degree to which historical legacies resonate.

Ultimately, what we have hoped to achieve here is a more open debate about the efficacy of cluster thinking for urban development policy-making (see also Darchen, 2015; Shearmur, 2015). Clusters cannot be easily invented or lured into existence in the face of longer-run inheritances. Meanwhile, more complex geographies that are much less easy to grasp underpin the manner in which many innovative firms now operate and source value. As well as agglomerative tendencies, historical path dependent and centrifugal geographic factors shape the conditions of possibility for hopeful policy moves. Understanding both the deeper histories and extra-local geographies that situate observed clustering dynamics is therefore necessary to avoid aggrandizing the true significance of the urban innovation cluster.

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14. Beyond networks in clusters
Franz Huber and Rune Dahl Fitjar

14.1 INTRODUCTION

Although Michael Porter’s popular marketing campaign took place a while ago, many policy makers still appear to be captivated by the idea of increasing competitiveness through clustering. While there appears to be a certain degree of saturation with the idea of clusters among academics, the role and functioning of spatial concentrations of firms in the same or related industries are still key questions for regional economic development and innovation studies. Cluster theories and policies come in various shapes and forms, but a common trait is the explicit or implicit assumption that a mere spatial concentration of industries will almost automatically be associated with beneficial knowledge networks and knowledge spillovers, which, in turn, facilitate innovation. Furthermore, it has become increasingly accepted that inter-organizational networks at multiple spatial scales are important for innovation, often based on the argument that non-local sourcing of complementary or new knowledge is vital for being innovative. Yet, despite the voluminous body of work on this topic, more empirical work is needed in two areas. First, we need to gain a better understanding of the qualitative mechanisms of inter-organizational networking and the related knowledge transactions at multiple spatial scales. Second, there is a need for further research on the causal interrelationships between innovation and networks of various quality and at different spatial scales. This chapter aims to address these issues by selectively reflecting on recent contributions by the authors and related work. First, in Section 14.2 we outline some conceptual foundations of our work on networks. Section 14.3 outlines unresolved questions in the literature, which have motivated our research. On the basis of this research, we discuss the limitations of networks in clusters in Section 14.4, and in Section 14.5 we elaborate upon the importance of global networks and non-geographical proximities for innovation. Finally, Section 14.6 concludes.

14.2 CONCEPTUAL FOUNDATIONS: PERSONAL AND FORMAL NETWORKS

The role of space in innovation processes is, often implicitly, conceptualized in various ways (see the Introduction to this Handbook). This ranges from space as a container of processes, where geographical distance as a metric variable is considered in a rather simplistic fashion (Huber, 2012c), to relational approaches, where spatiality is integrated in the understanding of relationships between actors (Bathelt and Glückler, 2003, 2011). In our research, we have adopted a relational perspective, whereby actor characteristics as well as interactive relationships between actors at multiple spatial scales are assumed to drive regional economic development. Here, spatial characteristics such as the role
of permanent and temporary co-location, effective geographical proximity or proximity in various non-geographical dimensions can be considered inherent elements of relationships and interactive processes, which contribute to innovation outcomes. In the following sub-sections, we outline the conceptual foundations of our research regarding inter-organizational networks, stages of network mechanisms and individualized networks beyond coherent communities.

14.2.1 Personal and Formal Inter-organizational Networks

Much of the discourse on networks in economic geography has tended to privilege inter-organizational networks at the firm level, thereby neglecting inter-personal relationships across organizational boundaries. Formal networks built on formalized relationships such as cooperative arrangements, alliances, joint ventures, sub-contracting or licensing (Segelod and Jordan, 2004; Trippl et al., 2009; Fitjar and Rodríguez-Pose, 2011) have been subject to a high volume of studies. This has often had the consequence that “lower-level” networks, such as among individuals or groups, are subsumed under “higher-level” networks among firms’ (Grabher and Powell, 2005, p. xxiii). Positive exceptions include, for instance, the contributions by Huggins and colleagues, who distinguish between social capital and calculative network capital (Huggins et al., 2012; Huggins and Thompson, 2014). In our research, we aim to be attentive to the individual level and to personal relationships across organizations. We conceptualize personal relationships as any interaction between individuals that goes beyond official/formal collaboration and formal roles. Such relationships can be of a purely informal nature, and can cover all types of informal relationships, or they might be embedded in co-existing formal relationships. Importantly, these interactions are driven by the inter-personal level and go beyond formal arrangements. To clarify the terminology, we define personal networks as a set of individuals in combination with their personal relationships; personal contacts are people with whom individuals have personal relationships. Social capital can be defined as the resources acquired through personal networks (Huber, 2009).

Since learning as a process, and most of knowledge transactions, take place at the level of individuals (Malmberg and Power, 2005, p. 421), different positionalities of individuals in organizations may lead to different social and communicative patterns. As Huber (2013) shows, knowledge sourcing behaviour tends to differ significantly between different job positions. In particular, there is a clear tendency that the lower the job position, the lower the importance of external personal networks for knowledge sourcing. The most important and unique knowledge sources obtained through external personal networks tend to be acquired by senior managers (Huber, 2013). However, the flow of technical knowledge tends to be less important than much of the literature on knowledge flows and spillovers in clusters suggest (Huber, 2012a). Overall, therefore, sensitivity to the positionality of individuals in organizations is promising for both research and practice.

14.2.2 Stages of Network Mechanisms

Networks should not be considered as static configurations: their linguistic or visual representation can only be a snapshot of dynamic network mechanisms (Glückler,
Beyond networks in clusters

2007; Bouba-Olga et al., 2015). For instance, Balland et al. (2015) have stressed co-evolutionary dynamics between proximity and knowledge networks. A comprehensive understanding of the role of inter-organizational networks for innovation requires an appreciation of various stages of network mechanisms. In particular, the stages of network formation, network maintenance and network-supported knowledge interactions can be distinguished, and each of these stages may involve specific socio-spatial qualities (Huber, 2012b). As discussed in Sub-section 14.5.2 below, the role of spatial proximity appears to vary considerably for the different stages of network mechanisms, and relative weight of formal versus informal interactions may also transform over time.

14.2.3 Individualized Networks Beyond Communities

In much of the literature on knowledge interactions within networks, the collective nature of interaction in groups or in (physical or virtual) communities has been stressed, often referring to the notions of communities of practice or epistemic communities (Benner, 2003; Amin and Cohendet, 2004). These concepts shed light on collective learning and knowledge sharing mechanisms in groups of knowledge workers (Knorr-Cetina, 1981; Wenger, 1998), but there is some conceptual ambiguity in the literature (Roberts, 2006). As discussed in detail in Huber (2012b), there is evidence that many knowledge relationships do not operate as part of coherent communities/groups but within individualized networks, where knowledge interactions often take place in dyadic relationships rather than in coherent groups. As argued by Rainie and Wellman (2012), this may be part of a general transformation from a group-based society to a society driven by individualized networks, where each individual manages his or her relationships according to individual needs, wants or tastes. In our view, the network concept is useful as a generic framework, but the question of the exact institutional architecture of knowledge interactions (whether through certain types of communities or dyadic relationships) needs to be addressed empirically.

14.3 UNRESOLVED QUESTIONS

Reviewing the literature on clusters, knowledge flows and networks would be a daunting task. From Marshall’s contribution in the nineteenth century to the present day, a remarkable amount of literature on these topic areas has emerged with economic geographers, economists, business and management scholars and sociologists contributing to this discourse. Instead of trying the impossible task of providing an overview of the literature in a few paragraphs, we aim to selectively stress a few questions, which we believe deserve further research.

Malmberg and Maskell’s (2002, p. 434) observation that firms located in clusters are too often assumed to benefit from hypothesized knowledge spillovers without an investigation of the specific mechanisms through which these spillovers occur is still valid. Furthermore, the ‘new economics of innovation’ (Feldman, 1999; Audretsch and Feldman, 2003) has stressed the significance of local technological knowledge spillovers by using knowledge production functions or patent citations (Jaffe et al., 1993) as indirect
indicators. Yet, those indirect indicators cannot directly shed light on the alleged mechanisms (Breschi and Lissoni, 2001; Döring and Schnellenbach, 2006; Henderson, 2007).

Although multi-scalar perspectives, which stress that networks at various spatial scales matter for innovation, have become widespread, ideas such as local ‘buzz’ (Bathelt et al., 2004; Storper and Venables, 2004) and ‘noise’ (Grabher, 2002) take up Marshall’s idea of ‘industrial atmosphere’. These ideas assume that actors in clusters ‘are automatically exposed to news reports, gossip, rumours and recommendations about technologies, markets and strategies by just being in the cluster’ (Bathelt, 2005, p. 206). Yet, there is rather little empirical research that systematically investigates these assumptions to clarify which mechanisms are actually operating and how.

Importantly, as alluded to above, research needs to pay more attention to the question of whether networks are mainly driven by personal relationships that are of a private nature, whether personal relationships are part of official inter-organizational relationships or whether inter-organizational relationships are ‘de-personalized’ in official institutional arrangements. This obviously will make a difference in terms of the governance of relationships and associated resource flows (Huggins et al., 2012).

Overall, instead of assuming that inter-organizational networks are generally important for innovation, we need more contingency-theoretic research to critically examine which types of networks at which spatial dimensions are important in which contexts.

Regarding the global dimensions of networks for innovation, further unpacking the global pipelines metaphor would advance the debate. First, we need more research on the qualitative nature and typologies of international networks (for instance, formal versus personal networks) that matter for innovation. Second, we need to know more about the relative significance of various spatial scales, for instance, whether international networks are complementing or substituting regional or national networks. Third, the recent concepts of ‘global buzz’ and ‘virtual buzz’ have triggered some empirical work, but their role for innovation still needs to be clarified.

14.4 ON THE LIMITATIONS OF NETWORKS IN CLUSTERS

In this section, we discuss our empirical insights on the limitations of networks in clusters by highlighting (1) the lack of need or opportunity for local networks; (2) the existence of cluster benefits that are not related to networks; and (3) the limited role of local networks for innovation outcomes.

14.4.1 No Perceived Need or Opportunity to Benefit from Local Networks

Research on the Cambridge information technology (IT) cluster has revealed that many senior managers/research and development (R&D) managers/engineers do not see any need to seek benefit from the local cluster. Reasons for this include relevant partners being located anywhere in the world, having sufficient in-house resources and recruitment taking place outside the cluster. Furthermore, several cluster actors do not perceive any opportunities in the cluster because there are no competent cluster firms in their highly specialized field or they do not find opportunities to interact with others because of severe time pressure. In addition to a lack of opportunities to benefit from clusters,
there may even be potential disadvantages to clustering. This is an under-researched question, which deserves further investigation (Huber, 2012c). Indeed, clustering can, for instance, lead to considerable disadvantages, such as high costs for office space and labour, which appears to be the case for popular places such as Cambridge (Huber, 2012b) or London (Wainwright and Huber, 2015). This will be of particular disadvantage to cost-sensitive start-ups and small firms, which may be squeezed out by high costs or by local competition for talent.

14.4.2 Cluster Benefits Beyond Networks

Importantly, in the case of the Cambridge IT cluster, the two benefits of locating there most frequently cited by cluster actors do not concern inter-organizational relationships in a narrow sense. Instead, first, labour market advantages (‘always finding a good job without having to move house’) that make recruitment easier. Second, being associated with the Cambridge brand, often without any inter-organizational relationship within the cluster, facilitates marketing and attracting labour.

Formal business links within the cluster are relevant and beneficial for only a small sub-set of clusters firms. This concerns technological niches where local customers or collaboration with the University of Cambridge are instrumental.

The role of personal networks is also limited. Local networking institutions were only helpful for one interviewee. Importantly, as elaborated upon in Huber (2013), the significance of personal networks varies according to different positions in the job hierarchy. The lower the job position, the less important are external personal networks. Conversely, useful access to knowledge via personal networks largely concerns business knowledge for senior managers, such as knowledge on how to expand a business, opinions about potential business partners or how to manage difficult situations with people. Also, all interviewed entrepreneurs who set up their business in Cambridge found the cluster important during the start-up phase because of local infrastructure, venture capital opportunities and institutional support. However, access to technological knowledge via networks is only mentioned very infrequently as being a benefit of locating in the cluster. For technological knowledge, alternative sources of knowledge such as internal colleagues, online communities or alternative sources online are widely regarded as a more important, and often superior, substitute.

14.4.3 Limited Role of Local Networks for Innovation Outcomes

Even when local networks are used frequently by firms and individuals, they are not necessarily helpful in promoting innovation. Research on Norwegian city regions reveals a large amount of local interaction, but there is no empirical association between innovation and having local networks. Looking at inter-organizational networks, Fitjar and Rodríguez-Pose (2011) found that 81 per cent of the 1600 companies sampled collaborated with at least one partner within the region. However, the firms that collaborated with regional partners were no more innovative than those that didn’t. In a regression analysis, neither regional nor national partners had any significant effect on four types of innovation outcomes. Fitjar and Huber (2015) extended this approach to the study of individual networks, finding that around 60 per cent of managers had personal contacts
at the local scale which were important for gaining work-related knowledge. However, the level of innovation in these firms was similar to that in firms where local managers did not report having local work-related contacts. Indeed, in a regression analysis controlling for other characteristics of the firm, the use of local or regional personal contacts actually had a significant negative effect on the likelihood of process innovation. While these analyses cover all industries within Norwegian city regions and do not focus on clusters or clustered industries in particular, they do nonetheless raise questions about one of the central tenets of cluster theory: that local interactions are important to innovation.

14.5 ON THE IMPORTANCE OF GLOBAL NETWORKS AND NON-GEOGRAPHICAL PROXIMITIES

As indicated above, there is a need to substantiate the global pipelines metaphor. In this section, we reflect on our findings on the role and functioning of global networks. We discuss the role of global networks for innovation outcomes, followed by the role of spatial proximity, and finally we elaborate on the role of non-geographical types of proximity.

14.5.1 The Importance of Global Networks for Innovation Outcomes

While local interaction has been shown to make very little difference to innovation for Norwegian firms, as discussed above, interaction with partners abroad tends to have a great impact. This form of interaction is less common among firms, being used by 45 per cent of the firms sampled in Fitjar and Rodriguez-Pose (2011). However, these firms tend to be significantly more innovative than other firms. Controlling for industry, size, ownership and various characteristics of the manager, as well as for their regional and national networks, the addition of a new type of international partner still improves the odds of product innovation by 21 per cent and radical product innovation by 26 per cent. The effect is even greater for international personal contacts. If the manager of the firm reports having at least one personal contact abroad who is useful for collecting work-related knowledge, the odds of product innovation and radical product innovation are more than twice as high as in firms with managers without such contacts (Fitjar and Huber, 2015). To illustrate this association in practical terms, while 38 per cent of managers of innovative firms have personal contacts in Europe, only 16 per cent of managers of non-innovative firms have such contacts. Similarly, 18 per cent of managers of innovative firms have personal contacts in the USA or Canada, while only 5 per cent of managers of non-innovative firms do. Besides increasing the likelihood of innovating in the first place, collaboration with international partners also tends to increase the returns to innovation for innovative firms. Fitjar et al. (2014) show that an average innovative firm with no international partners earns 12 per cent of its income from new products, while a similar firm with international partners in all categories earns on average 26 per cent of its income from new products. These results suggest that, in particular in countries with a limited national innovation base (due to country size or limited innovation activities), global networks are particularly important for innovation outcomes.

It seems likely that there are two types of causal relationships between international
networks and innovation (Fitjar and Huber, 2015). First, interaction with international network partners and associated acquisition of knowledge may make firms more innovative. Second, international networks may not make the firms more innovative but innovative firms may need them as a consequence of their innovation activities. In other words, innovative firms may have a greater need to engage with external partners as a consequence of their innovation activities, for instance, to secure equipment, consultancy advice or training.

### 14.5.2 Spatial Proximity for Forming and Maintaining Global Networks

It is important to appreciate that global networks for innovation do not imply that spatial proximity is irrelevant. Huber (2012b) has highlighted that a more elaborate perspective on the role of spatial proximity for knowledge networks requires a dynamic perspective of network mechanisms. An investigation of the development of personal relationships over time revealed that most of the relationships were formed in contexts of permanent or temporary spatial proximity, in particular, through working together, at professional events or as fellow students at university. This common past experience, anchored in spatial proximity, appeared to have shaped the social and cognitive connections between people, which subsequently led to work-related knowledge flows across organizations. Yet, face-to-face interaction is less important for maintaining such personal relationships. Relationship maintenance practices often take place via technologically mediated forms of communication, while more episodic face-to-face meetings can help revitalize the bonding: 'It [acquiring work-related knowledge] would almost certainly have been instant messenger, almost certainly. Yes, we tend to be too drunk when we meet face-to-face to pass useful knowledge' (Huber, 2012b, p. 369). This quote from a development director of a software company illustrates the relevance of distinguishing between the spatialities of network maintenance versus those of work-related communication. For the contexts where actual transfers of work-related knowledge take place, face-to-face tends to be even less important than for maintenance.

### 14.5.3 The Role of Non-geographical Proximities: Substitution Mechanism and Goldilocks Principle

One important insight in the literature on networks is that proximity of some sort – though not necessarily geographical proximity – matters for the operation of relationships (see Ferru and Rallet, Chapter 5, this volume). In particular, it has been argued that next to geographical proximity, alternative dimensions of proximity, such as social, cognitive, organizational or institutional proximity, are important for knowledge interactions and innovation (Boschma, 2005; Lagendijk and Oinas, 2005; Torre and Rallet, 2005; Lagendijk and Lorentzen, 2007). On the one hand, some sort of proximity has been argued to be critical for enabling successful interaction between actors. On the other hand, too much proximity may reduce the scope for learning and of being exposed to novel ideas, which may hamper innovation (Nootboom, 2000). While Boschma and Frenken (2010) have called this tension the ‘proximity paradox’, Fitjar et al. (2015) have argued that in a strict sense it is not a paradox because there is no inherent contradiction but rather a possible tension. We proposed the term ‘Goldilocks principle’ to refer to
collaboration with innovation partners needing to be neither too close nor too distant, but at a distance that is ‘just right’. The underlying assumptions of the Goldilocks principle are that, first, collaborating with external partners is beneficial for innovation, and, second, a medium level of proximity delivers the best innovative returns to collaboration. Under a generalized version of the Goldilocks principle, an optimum medium level of proximity would exist for all non-geographical types of proximities. Yet, the Goldilocks principle may only apply to certain types of proximity. Cognitive proximity may be most critical: Broekel and Boschma (2012) and Nooteboom et al. (2007) maintain that there may be an optimal level of cognitive proximity for innovation in the sweet spot between too high (risk of redundancy) and too low (risk of non-comprehension), but more empirical research is needed to shed light on this question. Moreover, an alternative way to address the ‘proximity paradox’ could be that high proximity in certain dimensions are compensated for by distance in other dimensions (Boschma and Frenken, 2010; Huber, 2012d). In other words, the optimal level of proximity for any one dimension may be dependent on the levels of proximity in other dimensions.

This leads to the question of how different proximities are interrelated, and here two propositions can be developed on the basis of previous literature (Fitjar et al., 2015). First, according to the overlap mechanism, geographical proximity facilitates non-geographical types of proximity. This tends to be very much the traditional view in the economic geography literature (Saxenian, 1994; Malmberg and Maskell, 2006). Second, according to the substitution mechanism, distance in one type of proximity can be bridged by proximity in other types (Menzel, 2015). That is, according to this view, a compensation mechanism is in place, which has been empirically confirmed by Huber (2012d). Overall, while recent research has started to explore the overlap versus the substitution mechanisms (Huber, 2012d; Hansen, 2014; Fitjar et al., 2015), there is a need for more empirical research to examine their prevalence and contextual determinants.

14.6 CONCLUDING REMARKS

In this chapter, we have provided some thoughts on the limitations of the discourse that emphasizes the role of local networks in innovative clusters, and have done so in light of our own empirical findings and associated research. We highlight the importance of making a conceptual distinction between personal and formal networks, of distinguishing between stages of network mechanisms and of acknowledging the fact that individualized networks may extend beyond coherent communities.

We discuss some of the weaknesses in previous research, and then we move on to elaborate on reasons why localized networks in clusters may in fact be quite limited, due to lack of perceived need or opportunity to benefit from them. We do not claim that clusters do not generate any positive effects for innovative firms, but we argue that widespread assumptions, in particular, those pertaining to the role of local technological knowledge networks and knowledge spillovers, may be misguided. We suggest that alternative benefits of clustering, such as branding and labour market advantages, may be more important. We argue that while business knowledge exchanges among senior managers and entrepreneurs within clusters tend to be useful, technological knowledge networks appear to be highly limited. Within the context of Norway, we illustrate – referring to
our previous work – that even if regional networking takes place, it is not statistically associated with higher innovation outcomes. In contrast, it is international networks that are related to innovativeness, and we argue that, particularly in the context of a limited national innovation base, international networks can be vital for innovation and may indeed substitute for local ones. This does not mean that spatial proximity and face-to-face interactions play no role, but we illustrate how spatial proximity tends to be most important for the formation of networks, while it tends to be less important for actual knowledge exchanges.

We also contribute to clarifying the role of various types of proximities with regards innovation by presenting empirical evidence for the Goldilocks principle, that is, a medium level of proximity delivers the best innovative returns to collaboration: the distance between collaboration partners for innovation needs to be ‘just right’. Further research is of course necessary to determine for which types of proximity the Goldilocks principle is most critical. Also, we need to gain a better understanding of how proximity categories interrelate and to what extent, and how overlap versus substitution mechanisms operate (Huber, 2012d; Hansen, 2014; Fitjar et al., 2015). The interplay between networks at various spatial scales, as well as the potential combined effects of different kinds of proximity, needs to be examined in more detail, as stressed by Bathelt and Cohendet (2014). Clearly, moving the debate on proximity for innovation from statics to dynamics is an important avenue, and empirical research on this has only just begun (see Balland, Chapter 6, this volume). On top of the challenge posed by longitudinal research designs, further development and refinement of the evolutionary conceptual framework is necessary.

At a more general level, there is clearly considerable need to further examine the causal mechanisms that underpin the connection between inter-organizational networks and innovation, and investigate the causal mechanisms underlying the role played by different types of proximities/distance with regards innovation (Hutzschenreuter et al., 2015). A final point that we make in this chapter is that a focus on inter-organizational networks may overlook alternative forms of non-interactive learning within clusters, as stressed by Glückler (2013), which deserves more attention in future empirical research. In light of the various questions we highlight in this chapter, we hope to have underscored that there are still fascinating puzzles to solve in research on innovative clusters, provided one looks beyond local networks.

REFERENCES


15. Suburban creativity and innovation

Alison Bain

15.1 INTRODUCTION

Cities around the world have become intensely suburbanized. Several decades of profound demographic growth and urban restructuring have rapidly transformed the morphology and use of suburbs; yet, as I argue in this chapter, urban cultural policy and planning have inadequately grappled with this suburban structural and cultural complexity. Since the closing decades of the twentieth century, a fast-policy model of neoliberal ‘cultural urbanism’ has been internationally deployed that targets the central city as the key site of creativity and innovation to the neglect of the suburbs (Peck, 2011). Culture-led urban redevelopment treats culture as the ‘software’ of cities and the built fabric as its ‘hardware’, often without meaningfully addressing the social inequities that riddle urban environments (Calthorpe, cited in Meyer, 2014). Such amenity-driven urban revitalization strategies are formulated to secure competitive advantage by prioritizing the clustering of cultural and creative industries in the inner-city as a way to foster innovation and the symbolic dimensions – the ‘buzz’ (non-deliberate information and knowledge exchange), dynamism, and ambience – of creative cities (Bathelt et al., 2004). As I reveal in this chapter, what is often lost on policymakers in this paradigm of prescriptive creative urban policy are the socio-spatial divisions that are accentuated between city and suburb and between haves and have-nots (Peck, 2012).

15.2 THE PLACE OF CREATIVITY AND INNOVATION IN THE ‘COGNITIVE-CULTURAL ECONOMY’

Richard Florida’s (2002) work on the creative class, knowledge-based and creative industries, and the creative economy of cities has initiated significant international scholarship on, and institutional support for, creativity as a stimulant to innovation and a driver of economic growth (Baycan-Levent, 2010). Creativity, or the generation of novel and valuable knowledge, is a dynamic topic of study in diverse disciplinary fields: geography, sociology, urban studies, organizational studies, anthropology and art history. Scholarly debates on the role of creativity in the ‘cognitive-cultural economy’ and urban and regional development have fixated on the locational factors that attract young, mobile creative professionals to cities, not suburbs (Scott, 2014). The ability to attract and retain creative people who innovate is directly equated with the knowledge innovation capacity and regional economic advantage of cities (Blake and Hanson, 2005).

The human capital approach to urban economic development sponsored by Florida’s Toronto-based think tank, the Martin Prosperity Institute, focuses on proxy indices of talent, technology and tolerance as important preconditions for fostering business formation, job creation and economic growth. The ‘soft’ quality of place cultural
amenities and ‘hard’ cultural infrastructural assets that are marketed to attract and service the creative class – vibrant street life, café culture, arts districts, art galleries, music scenes and arts festivals – are understood by Florida (2002) to be concentrated in central cities not suburbs (yet, he also claims that higher income knowledge workers reside in suburban areas because of the perceived higher quality of life). ‘A Bo-Bo (Bourgeois Bohemia) downtown’ is the lure used ‘to attract a labour pool, which in turn will attract high-tech industries, and lead to growth’ (Pratt, 2008b, p.108). But, as critics of creative city policy have warned policymakers, while it may offer ‘a seductively glowing vision of urban potentialities’ it is ‘attended by heavy social costs and disappointments’ (Scott, 2014, pp.573, 566). Most urban residents do not belong to the policy-privileged creative class and do not benefit from urban development based on creativity (Peck, 2005; Parker, 2008; Pratt, 2011; Oliveira and Breda-Vázquez, 2012; McLean, 2014). In North America, most residents also live in the suburbs (Harris, 2015).

15.3 CREATIVE CITIES/INNOVATIVE CITIES

Creative cities – commonly positively understood by academic researchers and policymakers as ‘dynamic locales of experimentation and innovation’ (Bradford, cited in Baycan-Levent, 2010, p.586) – are not represented as suburban. ‘Non-urban spaces’, like the ‘non-creative classes’ are consigned to ‘the scrap-heap of economic dynamism’, rendered obsolete in the ‘innovation game’ (Shearmur, 2012, p.S9). In the dominant scholarly narrative, suburbs are dismissed as too young and too new to be creative. These are places that are framed as the antithesis of all that is unique, interesting, genuine or authentic. Within the global urban hierarchy, not all cities – and, in this case, suburbs – are created equal (Rekers, 2012). From a European perspective, building creative cities and creating the preconditions that foster urban innovation has been shown by Peter Hall (1998) to be lengthy and incremental processes with deep historical roots. The accumulated knowledge and competence base that accompanies historic development paths influence future creative capacity. Consequently, the complex interdependencies of a strong social and cultural infrastructure need to be well established for a city to be globally recognized as creative and/or innovative (Pratt, 2008a).

Where creativity ‘is the means to an end’, innovation is ‘the extended follow-through that takes creativity beyond the local spark to the global bazaar’ (Brown, 2010, p.120). Creativity and innovation are two different, yet interdependent, ways of changing reality. Brown (2010) asserts that the culture of creative cities, which has been around for millennia, is not the same culture as that of innovative cities, which are more recent products of the industrial enlightenment. In theory, creative cities are able to use cultural capital to create new economies of innovation, research and artistic production and to generate unique place-identities (Sape, 2014). Innovative cities, on the other hand, are fuelled by the new wealth of entrepreneurs generated by creative activities that are less about individual self-expression and more about economic, technological and scientific accomplishment. Nevertheless, ‘[t]echnologically innovative cities and culturally creative cities are similar in that each would maintain a core of carefully developed competence in multiple areas of knowledge, be relatively unregulated, attract talented outsiders, support the
idea of the heroic individual and have infrastructures that promoted encounters’ (Brown, 2010, p. 121).

Serendipitous face-to-face interaction has been shown by economists to produce cross-fertilization between sectors and industries, particularly with respect to the multidimensional communicative dimensions of a tacit ‘knowledge base’ where learning is facilitated by doing and project completion is supported by knowing who has the appropriate technical skills (Asheim et al., 2007). Physical and relational proximity is posited to result from urban diversity and to ‘create unique opportunities for innovation and collaboration’ (Curran, 2010, p. 874). Innovation, with its collective approach to learning and future-oriented outlook based on replacing what exists (for example, products, processes, techniques and urban fabric) with something new, is perceived as central to the competitiveness of city-regions in the global economy (Rondé and Hussler, 2005; Malecki, 2007; Mieg, 2012; Nathan and Lee, 2013). It is the diversity, range of stimuli, infrastructure, market access and density of suppliers and workers commonly found in urban environments that are thought to foster innovation (Lee and Rodríguez-Pose, 2014). Such cost-and risk-reducing externalities are also correlated with city size. Thus, larger cities are popularly thought to spatially concentrate knowledge, learning and innovation (Simmie, 2005; Stolarick and Florida, 2006).3

Creative and innovative cities are the places from which analytical, synthetic and symbolic knowledge bases are recombined through different space-time engagements to produce new knowledge. While such knowledge transactions are central to ‘the new wealth of cities’ (Montgomery, 2007), Brown (2010, p. 126) cautions that places – particularly suburban places – can become disconnected: ‘the suburban, not just suburban places but suburban influences on places, needs to become connected to the larger urban place and its influences’. There is a real need, I argue, to rethink notions of creativity and innovation from the outside in – from the perspective of suburbs and suburban cultural producers and practitioners. Such an approach is less concerned with standardized development formulas, benchmarking and checklists of requirements needed for a city to fast-track its way to becoming creative and more concerned with the micro-dynamics and networked complexities of local cultural development processes (Comunian, 2011). For it is the local embeddedness of networks that provides the institutional thickness necessary ‘for the development and exchange of the tacit knowledge that underpins adaptation and innovation’ (Curran, 2010, p. 872). I am concerned, then, with demonstrating how culture is embedded in the suburbs and is intimately connected to suburban opportunities and challenges.

15.4 CREATIVE SUBURBS

An emergent body of contemporary academic work on creativity critiques the metro-centricity of creative city discourse by examining how culture is produced in remote, rural, small and suburban places (for example, Gibson, 2002, 2011; Markusen and David, 2003; Gibson and Connell, 2004; Bell and Jayne, 2006, 2010; Gibson and Brennan-Horley, 2006; Danaher, 2007; Brennan-Horley and Gibson, 2009; Luckman et al., 2009; Sorensen, 2009; Waitt and Gibson, 2009; Mayes, 2010; Bain and Marsh, 2012; Denis-Jacob, 2012; Van Heur and Lorentzen, 2012; Bain and McLean, 2012, 2013a,
New conceptual space was crafted for suburban creativity with a special issue of the *Australian Geographer*, guest edited by Chris Gibson (2010, p. 3), that explores ‘the creative industries outside of major cities – in places that are physically and/or metaphorically remote, are small in population terms, or which because of socio-economic status or inherited industrial legacies are assumed by others to be unsophisticated, or marginal in an imaginary geography of creativity’. This special issue was republished as the book *Creativity in Peripheral Places: Redefining the Creative Industries* (Gibson, 2011). Several of the contributors also participated in a themed issue of the *International Journal of Cultural Studies* entitled ‘Creative suburbia: cultural research and suburban geographies’ that examines the role of the creative industries in contemporary suburban development (Flew et al., 2012). Many of these same scholars have been co-investigators in a large Australian Research Council Discovery project, ‘Creative Suburbia’, designed to challenge the logic that creative industries flourish in dense, inner-city environments by investigating the lived experiences of people working in suburban creative industries (Felton, 2013).

Inspired by this cutting-edge Australian scholarship, I too have challenged the geographic logic of the creative cities discourse that myopically locates creativity and innovation in the central city. In *Creative Margins: Cultural Production in Canadian Suburbs* (2013), I ask: what are the emergent models and practices of cultural production and creative practice occurring in the inner and outer suburbs? I use locality-based ethnographic analysis of the everyday practice of suburban cultural production to challenge an ordering of urban space that produces suburbs as the ‘sub-creative’, and a denigrated spatial ‘Other’ (Phelps, 2012). My intention is to reveal suburban cultural complexity, creativity and innovation in places that have been repeatedly disregarded as featureless, homogeneous cultural wastelands. I provide a portrait of suburban creativity that reveals the practical, hidden, temporary and spontaneous dimensions of the everyday working lives of cultural workers in suburbia. Through case studies from the city-regions of Toronto and Vancouver, I demonstrate that just because suburbs do not conform physically or socially to the image of dense, clustered cultural districts does not mean that they are ‘“uncreative” zones – places of domestic consumption rather than sites of innovation, the arts and creativity’ (Gibson and Brennan-Horley, 2006, p. 457). To judge parts of a city-region as less creative than other parts is to disparage political and cultural institutions and the cultural workers who live and work there.

Although much of North American suburbia was conceived without any artistic motivation, creative intentions and interventions are overtly and covertly embedded in many contemporary suburbs, if you have the time and inclination to look. Through the work of a new generation of suburban Bohemians, suburban cul-de-sacs, yards and homes have been transformed into counter-spaces of cultural production that may resist social conventions and property norms. While suburban cultural workers have been instrumental in challenging the dominant organization of suburbia through creative reinvention and adaptive reuse of space, it is also important to acknowledge the conventionality of much individual locational decision-making. Suburban cultural workers are drawn there by many of the same quality-of-life consumer preferences that attract the middle-class: affordable and spacious homes in family-oriented neighbourhoods that value closeness to nature, domestic convenience, freedom and privacy. For those cultural workers who own a car and a home, the suburbs are interpreted as creatively emancipatory spaces.
However, that emancipatory potential is also constrained by lack of formal, government-led investment in cultural infrastructure (particularly that which supports the process rather than the products of cultural labour) and by lack of public acknowledgement of the cultural work occurring here. Paradoxically, such disinvestment and accompanying invisibility is experienced as both liberating and constraining. It can provide opportunities to create with limited financial and institutional support but also less competitive and critical scrutiny. A significant drawback, however, is that it offers few ‘third places’ outside the home where connections can be made and feedback provided by professional peers (Oldenburg, 1991). Such infrastructural shortages have inspired cultural workers to selectively retrofit suburbia to better meet their creative needs.

I witnessed the establishment of informal community cultural service hubs by cultural workers as grassroots workspaces where they could meet individual and collective needs for learning, exchange of ideas and collaboration. People from different disciplinary backgrounds worked together and learned from each other, sharing knowledge and equipment. This suburban model of cultural production involves mutually supportive interactions that are ‘intermittent, irregular, informal, and not based on contractual agreements’; creativity happens in an ‘unplanned, haphazard, and flexible way’ in suburbia (Shorthose, 2004, p. 153). Suburban cultural work often has an explicitly non-economic dimension to it. It can be motivated by community development, educational, social justice or art-for-art’s-sake agendas that favour social utility and make it difficult to quantify in economic impact assessments (Shorthose, 2004). Nevertheless, it remains vital to value the range of intangible positive externalities that creative labour contributes to the quality of life in the suburbs by reinventing communities from the bottom up.

While suburban cultural workers can be interpreted as quintessentially middle-class in their residential choices, it is important to recognize that this relative conventionality does not necessarily encroach upon the creative place-making potential afforded by their presence. Suburban cultural workers may live in proximity to the status quo, but they also possess an ability to intellectually step outside it to critique and reimagine the suburban places they inhabit. Computer-facilitated communication networks aid this transformation process by helping cultural workers to sustain creative practices across extensive and potentially isolating geographies. The virtual realm is a significant site of social interaction, mobilization and local cultural activity planning that fuses with, and brings to life, material suburban spaces. In suburban cultural production, cultural resources and intelligence are regularly transferred in networked configurations between cyberspace and suburban space.

Suburban cultural workers, in their deployment of a ground-up approach to innovation and sociability, are artfully positioned to be significant agents of change in suburbia, yet their professional contributions to place-making are significantly underappreciated. Although suburban cultural workers ‘are adventurous, and take off without warning for territories not yet familiar to us, returning with words, images, movements, and sounds that fascinate, concern, question, disturb, reveal, fill us with wonder, or prepare us for changes in how we perceive things’ (Brault, 2010, p. 33–4), they are seldom added to lists of influential professionals and civic leaders (politicians, policymakers, urban planners, developers, architects, financiers and real estate agents) who play a documented role in transforming suburbs and in imagining suburban futures. These are lost opportunities.
15.5 FROM THE OUTSIDE IN: LEARNING FROM SUBURBAN CULTURAL WORKERS

Suburbs possess a more ‘forgiving infrastructure’ than their urban counterparts that is ‘characterized by more forgiving and diverse standards, norms, and traditions’ (Rekers, 2012, p.1922). They foster a space for creativity and experimentation that supports the development of new ideas and products, which might break with convention or accepted standards. The labour of suburban cultural workers reinforces the value of small-scale, incremental changes to suburban built form through adaptive reuse. Gradual and synergistic adaptations are underappreciated dimensions of suburban place-making. They are valuable for their ability to augment diverse citizen engagements in suburban public life across an interdependent city-region.

Suburban cultural workers hold great potential as agents of change in suburbia, but such a role requires much greater municipal acknowledgement and support. In the management of the cultural sector, particular attention ought to be directed towards fostering closer cross-generational, -disciplinary and -cultural ties. In suburbia, it is professional cultural workers, as opposed to amateurs, who are most neglected with respect to resource and training investments. Suburban municipal infrastructure investment planning should emphasize cultural production over consumption. Decentralized nodes of affordable cultural workspace ought to be sponsored along with operational funding for the arts and culture organizations and networks that sustain them. In lieu of continued substantive investment in flagship cultural mega-projects and festivals (which can be financially inaccessible to local cultural workers), a more significant impact could be had on the everyday lives of suburban residents, I argue, by attending to the unspectacular. Based on the Australian experience, Gibson et al. (2012, p.299) concur; they recommend ‘that unheralded and prosaic sites of suburban creativity’ such as ‘community halls, writers’ centres, youth music studios, and art spaces . . . deserve better and more sustained financial support’. In suburban Canada, it is the safety upgrades, retrofits and maintenance needs of older buildings that require investment. There are many ageing, low-rise suburban buildings that may not be of sufficient construction quality to merit full restoration but they could be retrofitted as informal community cultural service hubs for local residents. If adequately linked to public transit, such cultural hubs could help to reduce spatial disparities in suburban cultural infrastructure provision by becoming vibrant nodes of community creativity.

Cluster formation is a strategy well documented in the scholarly literature on regional economic development for its communicative advantages, such as strengthening institutional ties and incubating interpersonal networks of trust and sociality (for example, Ashim et al., 2007; Baycan-Levent, 2010; Comunian, 2011). Within the variegated geographies of the suburbs, however, where sites of creativity tend to be decentred and dispersed and socio-spatial relationships between cultural workers disjointed, a cultural district model is less relevant (Brennan-Horley, 2011). Certainly, many suburbs do not possess the café and bar networking ‘buzz’ associated with downtowns, but there are still numerous examples of retrofitted storefronts, strip malls and schools becoming informal, multi-purpose community cultural service hubs. This is a significant feature of the suburban geography of cultural production that deserves greater recognition by urban cultural policymakers. It is local creative spaces and talent that needs profiling and investment,
rather than perpetuating a celebration of flagship cultural venues and outside creative and cultural consultant expertise.

Based on my interviews with suburban arts administrators, I advocate applying similar advice to cultural hiring practices. To help strengthen the bonds between suburban cultural institutions, organizations and local arts audiences it would be productive for a greater proportion of suburban arts managers to live and work in the suburbs that they serve, rather than commuting to them. The opportunities for mentoring local residents for future roles as cultural leaders in their respective suburban communities are then much greater. If the creative talent of suburban arts administrators and cultural workers at formative career stages is to be locally retained, cultural policy strategies need to be developed to better connect individual creatives to each other and to city-regional, national and global professional networks (Bennett, 2010).

Cultural activities in suburbia are often invisible to the uninformed. To all of my recommendations, increased media coverage and alternative outlets for communicating, advertising and building public awareness of local cultural workers, cultural activities and cultural spaces are essential (Bennett, 2010). The building of internal and external awareness about suburban artistic and cultural scenes helps to strengthen ties of trust and collaboration. Such ties not only assist with combating experiences of professional isolation but also with anchoring local scenes within wider cultural networks, both inside and outside city-regions.

Suburbs play a major role in creative city economies (Brennan-Horley, 2011). In order to reap greater benefits from this role, municipal decision-makers and policymakers must acknowledge three key points: (1) a significant proportion of cultural workers live and work in the suburbs; (2) suburban cultural work has a different geography from its urban counterpart; and (3) suburban cultural infrastructure needs investment. If creative city policies continue the business-as-usual economic indicator-driven model, cultural resources will continue to accrue in culturally rich areas of city-regions and exacerbate spatial inequalities that already exist in the cultural realm (Flew, 2011).

It is essential, therefore, that cultural policymakers participate in ‘whole-of-city thinking’ (Luckman et al., 2009, p.82). Such big-picture framing of cultural infrastructure inequities must consider distributional and access questions for central cities and suburbs, but also direct particular attention to the provision of suburban cultural resources (for example, money, services and facilities) that can develop multi-skilled creative activities inclusive of cultural expression, participation and production across the expertise spectrum from amateur to professional (Evans and Foord, 2003; Shorthose and Strange, 2004). Cultural policymakers can no longer afford to create policy from mechanistic economic impact assessments or city-centric policy transfer adaptations (O’Conner and Gu, 2010), but they continue to do so. The danger with imposing formulaic creative city agendas on places is that they run ‘roughshod over local needs, aspirations and already existing or vernacular creative expressions’ (Luckman et al., 2009, p.72). Ideally, suburban cultural policy should be developed incrementally in response to the specific needs of different local constituencies and material everyday realities. Such an ‘organic’ approach to cultural policy development can best be supported by scholarly ethnographic qualitative research that provides detailed documentation of the complexities and situatedness of suburban cultural work, and, in so doing, gives voice to the diverse lived experiences of real people in different times and places (Shorthose, 2004).
Contemporary suburbs are at a critical juncture in policymaking and place-making. In the current period of global economic uncertainty, suburban populations continue to age and suburbs are marked by tensions derived from cultural differences and income disparities. New communications technologies have also transformed work, living and consumption patterns. In light of all these demographic, economic and technological changes, suburbs could be where a new social contract for sustainable, creative and inclusive city-regions is forged (Ingersol, 2006). My research has shown that suburban cultural workers are well positioned to help negotiate the terms and conditions of such a social contract because of how effectively their socio-material practices uniquely texture, and work with, and for, suburban places. The mutually supportive relationships that suburban cultural workers continue to informally build between the arts and local communities require sustained municipal financial support and cultural policy recognition. Only when such resources and attention are reliably provided will it be realistic to envision culture reconstituting and socially cohering the city-region from the outside in.

15.6 CONCLUSIONS

Cultural and creative city policy has largely been focused on the central city to the neglect of suburbs, on the understanding that creativity and the attraction of talent are precursors to innovation and economic growth. Diverse creative locales on the peripheries of city-regions are marginalized in policy circles because of the hegemonic logic of neoliberal urbanism. Such an urban economic development logic privileges inter- and intra-urban competition, place marketing and market-led redevelopment prescriptions that favour gentrification, cultural clusters and the attraction of the creative class as best practice strategies (Curran, 2010). In this mix, it is important to remember that creativity and innovation are not, as Blake and Hanson (2005, p. 685) sagely remind us, ‘just products of place, but also of the people who are embedded in particular places: innovations emerge from the intersection of place and the social identity and positioning of the innovator and the innovator’. While creativity and innovation need to be geographically and socially contextualized, they are also mobile and can be produced anywhere (Shearmur, 2012; Sape, 2014).

Everyday suburban life writes itself in manifold different ways onto creative practices, cultural products and labouring bodies. The local possibilities for creativity and innovation depend, in part, upon the institutional thickness of places – the resources, distributional system, conventions and norms, and extent of cooperation – that shape how capital, information and ideas can flow from creatives to products/processes and to markets (Blake and Hanson, 2005). In order to more fully appreciate the extensive continuums of creativity and innovation, it is important for researchers to recognize that both can occur in any place and, consequently, to investigate a greater variety of geographic contexts. Rethinking where and how creativity and innovation occur has important implications for local economic development policy agendas. Suburban policymakers should be encouraged to financially and infrastructurally support the creative labour of local cultural workers whose services to diverse suburban communities can contribute to a more socially inclusive and equitable city-region. There is great potential in suburbs for creativity to be productively applied for social purposes – what is often
termed ‘social innovation’ – to help address injustices in a social and physical landscape still in formation (Oliveira and Breda-Vázquez, 2012).

NOTES

1. A ‘knowledge base’ denotes a particular area of knowledge and the ways in which it is embodied in techniques and organizations. Asheim et al. (2007; Chapter 2, this volume) employ a threefold typology of knowledge bases: analytical, synthetic and symbolic. Analytical refers to the scientific knowledge used to rationally explain features of the natural world. Synthetic refers to the applied engineering knowledge used to inductively design and construct solutions to human problems. Symbolic refers to the use of aesthetics, design and image to create new cultural meaning.

2. National innovation strategies also often treat knowledge creation as an urban phenomenon. Cities, Goldberg (2006, p. 646) cautions, ‘need infrastructure [in order] to be hotbeds or clusters of innovation’. In the Canadian context, federal and provincial governments have had a significant role to play in financing that infrastructure. Macro-national and provincial innovation policies to foster the economic performance of cities and regions play out locally through the provision of appropriate tax, regulatory and planning programmes (Howells, 2005).

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Suburban creativity and innovation


16. Innovation in peripheral regions

Arne Isaksen and James Karlsen

16.1 PERIPHERAL REGIONS: OVERLOOKED IN INNOVATION STUDIES?

It is an established fact in economic geography and innovation studies that firms’ innovation activities depend on their location. Martin (2010, p. 20), for example, maintains that ‘innovation is indeed often a highly localized phenomenon, dependent on place-specific factors and conditions’. Place-specific factors affect how firms organize and carry out innovation processes as well as the results that firms achieve. The relevant conditions are produced through the historical development of regions and they ‘reflect the economic, social, cultural, and institutional conditions inherited from the previous industrial and technological histories of a locality’ (Martin, 2010, p. 20).

The literature, however, often implicitly links innovation processes to the regional conditions typically found in dynamic core regions (Dawley, 2014; Isaksen, 2015). These regions often have a variety of clusters, firms’ research and development (R&D) organizations and a collection of research and higher education institutions (Tödtling and Trippl, 2005). Innovation in core regions builds on positive effects from urbanization economies, such as a local pool of specialized labour, local inter-firm division of labour, local supporting institutions, local knowledge spill-overs and various forms of traded and untraded interdependencies (Storper, 1997). Such conditions stimulate innovation processes as they provide fertile ground for hetero-geneous information flows, cooperative relationships and learning processes (Weterings and Boschma, 2006, p. 65).

Peripheral regions frequently lack the conditions typically associated with urbanization economies. These areas often suffer from low levels of R&D and innovation, the dominance of small and medium-sized enterprises (SMEs) operating in traditional and resource-based industries, fewer possibilities for the combination of different types of knowledge and thin and less specialized structures of knowledge and support organizations (Tödtling and Trippl, 2005; Virkkala, 2007). Key assets often linked to dynamic and innovative places are therefore scarce in peripheral regions. Current models that link innovation and place-specific factors cannot offer a sound theoretical framework for analysing innovation processes in the peripheries. Peripheral regions lie outside major theoretical debates and empirical generalizations with regard to geographies of innovation (Petrov, 2011).

This gap in the literature points to a need for empirically based, theoretical reflections about the specifics of innovation activity in the peripheries. Such work is also critical to ensuring that industrial and innovation policies in peripheral regions are based on sound knowledge of such regions and do not routinely build on theories that reflect experiences from well-known, dynamic core regions. The chapter discusses typical features of peripheral regions, then various characteristics of innovation activities in such regions illustrated by some empirical examples.
16.2 CHARACTERISTICS OF PERIPHERAL REGIONS: ORGANIZATIONAL THINNESS

The term ‘peripheral region’ is fuzzy in the sense that it may include different types of regions. When it comes to the innovation performance of a region’s industry both the presence of relevant local assets and the accessibility of extra-regional resources have a bearing (Shearmur, 2010). The accessibility argument relies on the fact that some types of innovation processes are stimulated by face-to-face exchange of knowledge. Firms located in regions in close geographical proximity to informal knowledge flows and a number of different knowledge providers in dynamic core regions are, all other factors being equal, better equipped to innovate than firms located further away from these resources. Thus, ‘it can be expected that the propensity to innovate will vary with distance from urban centres’ (Shearmur, 2010, pp. 63–4). In this chapter we focus on regions that are not in the vicinity of a large city region, that is, are located outside daily commuting distance from such a region.

The chapter focuses on the local assets typically found in peripheral regions, how these assets influence firms’ innovation activity and how firms use these assets in innovation processes. We employ the regional innovation system (RIS) framework in order to describe the ‘innovation environment’ of the peripheries. This framework argues that inter-firm interactions, knowledge and policy support infrastructures and socio-cultural and institutional environments may stimulate collective learning, continuous innovation and entrepreneurial activity (Asheim and Isaksen, 2002; Doloreux and Parto, 2005). The RIS approach builds on the fact that innovative firms frequently supplement their internal competence with external, specialist competence from a number of different actors (Lundvall, 2010).

Innovation systems in peripheral regions are characterized as organizationally thin (Tödtling and Trippl, 2005), but can simultaneously be institutionally thick (when institutions are conceptualized as ‘rules of the game’ (Edquist, 2005, p. 182)). This chapter views institutions as habits, norms, regulations and laws that influence behaviour and relationships between actors, that is, between organizations such as firms, universities and public organizations. Organizationally thin RIS have by definition (see Tödtling and Trippl, 2005) few or no higher education institutions and R&D institutes, no – or only weakly developed – clusters and consequently little local knowledge exchange and weak related variety. Lack of related variety leads to few options for combinations of related (neither similar nor totally different) knowledge within regions, which is believed to severely hamper innovations based on local resources (Boschma and Frenken, 2011). The firm structure in thin RIS often includes a relatively large number of SMEs, but also larger, externally owned, firms (Tödtling and Trippl, 2005). This structure may in some cases lead to a ‘branch plant culture’ where local actors assume that new jobs come from external investors, which hampers local entrepreneurship and innovativeness (Petrov, 2011).

The extent and type of knowledge exchange within and across RIS is heavily dependent on the type of institutions that dominate in a regional economy. Institutions are believed to smooth the process of knowledge and innovation transfer by lowering uncertainty and information costs (Rodríguez-Pose, 2013, p. 1038). Trust and social capital have been given the most attention in analyses of informal institutions (Rodríguez-Pose, 2013, p. 1036). Social capital is defined as ‘social networks and relations held together by
common norms and values (of which trust is one)’ (Westlund and Kobayshi, 2013, p. 5). A distinction is drawn between bonding and bridging social capital. Bonding refers to the internal network of a group or organization and the values and norms that keep their members together, while bridging social capital includes links between actors in different groups and organizations (Westlund and Kobayashi, 2013, pp. 5–6).

Social capital differs between regions and ‘is part of a region’s “collective personality”’ (Malecki, 2012, p. 1033). The cognitive part of social capital results from historical developments and is fairly ‘sticky’. Peripheral areas have mostly bonding social capital (according to Westlund and Kobayashi, 2013 who analyse rural areas understood as non-city adjacent countryside). Bonding social capital stimulates cooperation and knowledge exchange, in particular among well-known local actors who know the values and norms that hold the networks together. It follows from this argument that peripheral regions can be institutionally thick, as when actors in RIS are inward looking and become fairly homogeneous with regard to knowledge bases and ‘world views’. A recurrent argument is that ‘too much bonding social capital becomes negative, creating conformity rather than variety’ (Malecki, 2012, p. 1031). Conformity hampers knowledge spill-over and interactive learning amongst actors with a ‘related variety’ of knowledge and technology (Boschma and Frenken, 2011), which also hampers firms’ innovation performance.

16.3 INNOVATION IN A PERIPHERAL CONTEXT

16.3.1 Doing-Using-Interacting Innovation Mode

This section discusses in what ways characteristics of peripheral regions influence innovation processes, that is, we focus on the question of how peripheral firms often carry out and organize their innovation activities. We introduce the innovation mode approach (Jensen et al., 2007; Isaksen and Karlsen, 2012) to analyse that question. This approach outlines the primary ways of carrying out innovation activity, mainly based on which internal and external knowledge sources firms use for innovation purposes and how firms organize learning and innovation processes.

A basic distinction is between the science-based Science-Technology-Innovation (STI) mode and the experience-based Doing-Using-Interacting (DUI) mode. The DUI mode of innovation is based on learning from experience and competences acquired by employees on the job as they face new challenges and problems that have to be solved. The challenges may come from the firms’ own activities, but they often relate to the requirements and needs of customers and users (Lundvall, 2007). The innovation process in the DUI mode often takes place through daily work and often results in incremental changes in products and ways of doing things.

The STI (Science-Technology-Innovation) mode has a much stronger focus on science-based learning and R&D activities. Much of the innovation activity takes place within in-house R&D departments, research-intensive firms and universities and research institutes, with the intention of developing fairly radical innovations; knowledge creation is in large part based on the development and testing of formal, scientific models and includes elements of basic research. The innovation process is characterized more by the science push than the market pull of the DUI mode.
Isaksen and Karlsen (2012) have described a third innovation mode called Complex and Combined Innovation (CCI). This mode characterizes firms that, in different ways, link and adapt scientifically based and experience-based knowledge from different sources in innovation projects. This combination occurs when tacit knowledge is made explicit in firms and then mixed with scientific methods and knowledge both inside firms and with external knowledge organizations. CCIs often include several incremental innovations in the same product or a new technological platform for the firm.

The innovation mode approach is relevant to this discussion because specific innovation modes are unevenly distributed in space. This reflects the fact that firms and industries dominated by different innovation modes need different types of support from the institutional and knowledge infrastructure, that is, from the regional innovation system. DUI firms benefit from dense contact with some demanding customers and strategic suppliers and from access to experience-based knowledge, for example, through a local labour market. STI firms, on the other hand, acquire key, external knowledge from researchers at universities and research organizations. STI firms are biased towards large cities and specialist university cities (Cooke, 2002, pp. 130–1). In such urban locations STI firms have better access to researchers and research groups with new innovative ideas that have not yet been published than they would in peripheral regions with few or no higher education institutions. Academic spin-offs (which often result in STI firms) also tend to locate in larger cities or near universities (Feldman, 2007).

Organizationally thin regions have by definition few or no higher education institutions or R&D institutes. Such regions therefore often have comparatively few STI firms. A weak knowledge infrastructure and, often, dominance of traditional industries implies that thin, peripheral regions have more DUI firms. The Organisation for Economic Co-operation and Development (OECD, 2014, p. 50) also indirectly points to the importance of the DUI mode in rural areas when insisting that innovation in such areas ‘is grounded in actions of individuals looking for ways to solve specific problems’. A predominance of bonding social capital leads in the same direction, since it hampers the inflow of ideas and knowledge from actors outside firms’ ordinary business partners.

16.3.2 Little Local Combination of Knowledge

Peripheral regions with thin RIS are characterized precisely by limited and often path-dependent information and knowledge flows. This is due to the typical features of peripheral regions that we have pointed to: few related firms, few or no knowledge organizations and a predominance of bonding social capital. Firms in thin RIS can compensate for a scarce and conformal local knowledge supply base in two basic ways (Isaksen and Trippol, 2014). They can internalize some of the resources that are otherwise much more available externally to firms in large core regions and they can enter into geographically widespread collaboration networks (as discussed in the next subsection).

Manufacturing firms in the peripheral Norwegian region of Lister (located in between Stavanger and Kristiansand in the south-western part of Norway) have dealt with the drawbacks of being located in a thin RIS in part by building up deep and varied expertise inside the firms (Isaksen, 2015). Manufacturing firms in Lister often compete through flexibility and fast deliveries to customers, which are partly achieved by having key skills available internally to the firm; this also contributes to high levels of self-sufficiency. In
regions with far greater industrial activity firms have much better opportunities to find relevant competence nearby.

Thin RIS and scarcity of related firms also mean that firms can expect a relatively stable workforce, which is confirmed by statistical data in the Lister case (Isaksen, 2015). A stable workforce offers both an upside and a downside with regard to firms' innovation capability. The downside includes firms recruiting fewer new employees with potentially important complementary expertise, which may hamper firms’ innovation performance particularly with regard to ‘STI-type’ innovations. The upside of a stable workforce is that workers may over time achieve high experience-based competence that can be used in innovation processes of the ‘DUI type’. The chief executive officer of a mechanical engineering firm in Lister (with 150 employees) thus claims that the firm could barely ‘survive’ in the larger city of Kristiansand due to faster turnover of the workforce there as a result of more competition from better paid jobs in the oil sector, which would mean that accumulated expertise would disappear from the firm (Isaksen, 2015).

Disadvantages that can come from slow local knowledge flow and lack of related variety of knowledge are illustrated by the development of the marine biotechnology industry in Tromsø, the largest town in northern Norway with about 80,000 inhabitants. Tromsø is not an especially peripheral region as it is a quite large town, by Norwegian standards at least, but is nonetheless located in a very peripheral part of Norway and Europe. Marine biotechnology has been a priority industry in Tromsø since the 1990s. Considerable resources have been invested in creating a growing biotechnology industry, through both research activities at the University of Tromsø and policy tools to facilitate academic spin-offs, firm collaborations and so on (Karlsen et al., 2011). Tromsø has well-developed knowledge and policy infrastructures but little manufacturing industry.

Despite the significant policy resources, just a couple of hundred jobs and just over ten biotechnology firms have emerged in Tromsø. This reflects the fact that the marine biotechnology industry in Tromsø is fairly young and it takes time to develop this type of industry, where the commercialization phase often lasts a long time. But the firms also exchange little market-based or technological information and knowledge (Karlsen et al., 2011). The firms generally have close links with the University of Tromsø but few knowledge links exist between the firms themselves. The biotechnology firms are heavily geared towards R&D activity and the STI innovation mode. The firms and the Tromsø region (which is dominated by service industries) have less experience-based knowledge with regard to the installation and running of production lines, and also have little knowledge about how to commercialize research results. A skewed regional knowledge base in Tromsø, focused on science-based knowledge, therefore seems to hamper the commercialization of results from STI-dominated innovation processes.

16.3.3 Extra-regional Knowledge Sourcing

Since Bathelt et al. (2004) introduced the metaphor of local buzz and global pipeline, much attention has been devoted to the fact that firms benefit from employing both local and non-local competence in innovation processes. Local buzz refers to the fact that firms may acquire information and knowledge by spontaneously observing and monitoring the activities and improvements of other firms, primarily local firms. Firms receive a lot of specific information and inspiration through contact with actors with related and
complementary skills. Collecting information through buzz is sensitive to geographical distance ‘because they depend on face-to-face meetings and are nurtured by incidental meetings on the street and in civic life’ (Lorenzen and Maskell, 2004, p.81). This type of information sharing is rarely found in peripheral regions, but is much more common in dynamic core regions and regional clusters, which were the empirical background for Bathelt and colleagues’ conceptualization. However, the local buzz concept again underlines a preoccupation with large, core regions in theoretical reasoning on learning and innovation.

The paucity of local knowledge exchange in thin, peripheral regions makes geographically widespread collaboration networks (Herstad and Ebersberger, 2013) or global pipelines for knowledge flow to actors in different parts of the world more important. On the one hand, external connections can play an important role in bringing in ideas and knowledge in order to overcome shortcomings in the firms’ own knowledge and in the local knowledge base. On the other hand, it may be difficult to develop global pipelines in peripheral regions as, according to Westlund and Kobayashi (2013), these regions are often dominated by bonding social capital. They argue for the need to develop new forms of bridging social capital in the periphery. This is not a quick fix, as the cognitive part of social capital includes historically developed and region-specific norms and values, which can be hard to change and it often takes a long time before changes can be identified.

One part of a strategy to increase access to extra-regional knowledge is to raise the absorptive capacity of regional firms, for example, through recruiting well-educated and experienced people. This increases the ability of at least some firms (gatekeepers) in a region to identify and acquire external information, interpret and assimilate it, combine it with existing knowledge, share it with other firms and regional actors and then apply it to commercial ends (Cohen and Levinthal, 1990; Giuliani and Bell, 2005). Increasing the absorptive capacity through recruitment must be combined with an organizational learning strategy that involves key actors inside a firm. Without an organizational learning strategy firms may strive to combine external knowledge with internal knowledge in exploitation processes.

An empirical study in Norway found that innovative firms in peripheral parts of the country cooperate more during their innovation process than firms in central areas (Jakobsen and Lorentzen, 2013). One suggested explanation is that lack of local buzz in the peripheries makes formal cooperation agreements with extra-regional partners more necessary than in the central areas of Norway. The importance of extra-regional knowledge links is also evident in the history of the Farsund Aluminium Casting (FAC) plant, located in the Lister region. The firm produces aluminium parts for the European automotive industry as a first tier supplier and has nearly 300 employees.

FAC was established in 1998, under the ownership of the international corporation Alcoa. The factory is located beside an aluminium smelter owned by Elkem and Alcoa and heated, flowing aluminium is transported from this smelter to FAC’s production hall. FAC went bankrupt in 2009, following the financial crisis and the related problems for car producers. However, Porsche was then about to introduce its new Panamara model onto the market and FAC was the single producer of one vital part – rear suspension – for this model. FAC was, and still is, the only producer in the world able to make this part in one piece, as FAC has developed some unique technology and has workers with the necessary knowledge to use the technology. This led Porsche and BMW to guarantee
production by FAC for five years and Porsche then bought 70 per cent of FAC, which was resold to a German automotive parts manufacturer in 2012. The unique competence in FAC is partly embedded in workforce experience and partly in its integration to a Norwegian metallurgic innovation system with globally recognized expertise. FAC is quite R&D-intensive and has carried out several innovation projects financed by the Research Council of Norway in cooperation with Sintef, the largest independent research institute in Scandinavia, which operates in partnership with the Norwegian University of Science and Technology (NTNU) in Trondheim. The international competitiveness of FAC, located in a peripheral part of Norway, depends on its long-term links with national knowledge organizations.

16.3.4 Exogenous Development Impulses

The FAC case exemplifies another key dimension of innovation activity in the periphery, dependence on policy interventions. This does not mean that peripheral firms need to receive some particular long-term support from policy tools to strengthen the kind of ‘branch plant culture’ mentioned earlier. The idea is rather that some external investments, for example, the establishment of new firms by entrepreneurs or corporations from outside the region, may contribute to long-term development impulses.

One illustrative example of external investment and subsequent industrial development in a peripheral region is the growth of the information and communications technology (ICT) industry in Sardinia, as analysed by Ferrucci and Porcheddu (2006). The growth of the industry began with the establishment of an R&D institute in 1990, which was heavily supported by public money. The institute was not linked to the mainly traditional Sardinian economy. But the R&D institute created advanced scientific competence, acquired by a number of junior researchers, in computing engineering science, computer science and physics. The scientific competence was used by a local pioneer company in web publication, which recruited junior researchers. The pioneer firm was soon acquired by a large Italian company and downsized, which triggered the founding of many spin-offs by their employees. Another large internet communication company soon arose, partly started by entrepreneurs from the pioneer firm, which spurred the establishment of further ICT firms in Sardinia. The two large firms ‘brought about a nebula of spin-offs’ (Ferucci and Porcheddu, 2006, p. 218), which were often started by people who gained their skills and network from working in the large firms.

16.4 CONCLUSION

Peripherally located firms may be innovative. The argument in this chapter is that place-specific factors and conditions influence the innovation performance of firms in peripheral regions, as well as firms in other regions. Peripheral regions exhibit, however, different place-specific conditions to those found in dynamic core regions, which cause peripherally located firms to innovate in certain ways.

Many peripheral regions are characterized by organizationally thin regional innovation systems and bonding social capital. These are features that stimulate incremental innovations based on experience-based knowledge, which is typical of the DUI innovation
mode. It also stimulates the development of competence inside firms as, unlike firms in core regions, they cannot easily access many types of expertise from nearby firms and knowledge sources.

Characteristics such as many DUI innovations, little local knowledge flow, low related variety of knowledge and technology and high levels of bonding social capital may result in peripheral regions becoming trapped in path extension (Isaksen, 2015): firms and industries strengthen their existing activity through incremental innovation, while the development of new activities through radical innovations is difficult to achieve. Firms in peripheral regions, in particular, need to source extra-regional knowledge in order to achieve more radical innovation activity. This will often mean nudging DUI firms in the direction of CCI firms, which involves linking local experience-based knowledge with science-based knowledge found in external knowledge organizations and firms. The innovation activity in the firm FAC, described above, illustrates the CCI mode. Reliance on extra-regional knowledge sources also points to the fact that external investments and policy initiatives are especially important for industrial development in peripheral regions. Firms in peripheral regions, in particular, need to develop organizational learning strategies in order to be able to exploit external knowledge from distant sources in their internal innovation processes.

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Part V Innovation policy: introduction

Richard Shearmur, Christophe Carrincazeaux and David Doloreux

Research in innovation policy is increasing in importance as new innovation-related initiatives are being undertaken in different regions across the world, new regional innovation policy tools are being created and new public policy agencies are being established. Some of these policy-making entities are national innovation agencies, others are local development agencies attempting to leverage local innovation into local development – often understood as employment creation. The collection of chapters in Part V of the Handbook focuses on innovation policy, pointing out the relationship between public (innovation) policy, the search for regional competitiveness and the diversity of roles played by governments in the development and support of innovation and entrepreneurial regions.

The first contribution by Bradford and Bramwell (Chapter 17) analyses the core issue of innovation policy in a multi-level framework from an institutional perspective. Drawing on insights from the literature on economic geography and political science, this chapter provides a framework to analyse regional innovation policy based on the themes of governance, scale and agency, and it describes the regional innovation programmes underway in the European Union, United States and Canada. The sets of policy development models and policy frameworks adopted by governments of these countries to support clusters and regional innovation systems are discussed, providing insights that inform theoretical debate as well as policy development.

In Chapter 18 Uyarra and Flanagan continue the discussion on innovation policy, in this case with reference to the role of policy in regional innovation systems. The chapter provides a discussion of the way policy interventions and policy processes can themselves be understood from an evolutionary perspective. Their viewpoint is that the role of agency in policy and institutional changes is underplayed, arguing that public action can influence the conditions of path creation and the development of regional innovation systems.

The following two chapters examine specific policy contexts. In Chapter 19 Yang examines the dynamic interplay between state authorities, transnational corporations and domestic firms for technological catch-up in the context of globalization. The author bases her discussion on a case study of the Shenzhen region to illustrate the role of various state authorities (ranging from national to municipal governments) in helping and supporting technological dynamics. The author stresses that three scales of innovation strategy have an impact on China’s innovation policy, namely, national government, the integration of domestic industries into global value chain/global production networks and the regional innovation system. This chapter tackles the issue of how different levels of institutional structure and the interplay between different domestic and global economic actors enable (or constrain) regional economic innovation in China. In particular,
the role of the state in generating Shenzhen’s high-tech cluster is paramount, in contrast to the more organic understanding of cluster dynamics that characterize many of the other chapters in this Handbook.

The final chapter by Lawton Smith (Chapter 20) discusses how regions become entrepreneurial and which organisations are shaping visions and coordinating entrepreneurial activity. The author develops an entrepreneurial region model as a conceptual platform underlying three key dimensions, namely, entrepreneurial resources development, entrepreneurial vision and the role of the government in coordinating entrepreneurial activity. She analyses the regions of Oxfordshire and Cambridgeshire in the United Kingdom to illustrate how distinct patterns can be observed in the way the entrepreneurial region concept is developed at the local and regional levels.

These four chapters illustrate the complexity – due to the mechanisms and interactions involved – of defining what a successful innovation policy should look like with respect to regional policy interventions and actions. These chapters highlight the importance of acknowledging that governmental actions can influence conditions for the development of innovative regions, but illustrate at the same time the diversity of pathways that can be adopted by government to successfully support regional development. The chapters also highlight the fact that innovation policy often assumes that local innovation will lead to local development, without necessarily implementing policies that facilitate regional development (such as managing the housing market or ensuring local authority cooperation – as explained by Lawton Smith with respect to Oxfordshire). Other assumptions – such as the key role played by local universities in terms of collaboration and knowledge exchange – are also made, notwithstanding persistent evidence that there is nothing automatic about such dynamic local processes (Massey et al., 1992; Laursen et al., 2011; Huber, 2012).

Thus, while the policy-making process with respect to innovation is important and can be very influential, there is some disconnection between empirical evidence and assumptions that underpin policy making. Policy makers will often be attracted to the most popular ideas and to fairly straightforward concepts (clusters, proximity, local universities, research and development investment . . . ) – this is a prudent risk-minimizing strategy on their part. However, as academics, it is important that we think critically about the concepts that we, as a group, make popular, and on the way this popularity is assessed. Academic points and kudos can be gained by promoting an idea – whether it is valid or not, and whether it is applicable in all circumstances or not. This becomes problematic when these ideas are translated into public action. Alan Greenspan, looking back over the popular and academically unimpeachable ideas that led up to the 2007/08 financial crisis, admitted that ‘This modern risk-management paradigm held sway for decades . . . The whole intellectual edifice, however, collapsed in the summer of last year’ (New York Times, 2008). Although the paradigms and accepted wisdom that guide innovation policy – particularly at the regional level – are unlikely to have such widespread global impacts, they can lead to public money being wasted and false hopes being raised. Conversely, policy that rests upon a good understanding of particular processes and how they fit in to wider dynamics – and that takes heed of empirical evidence – can have positive impacts on local outcomes.
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Regional economic development: institutions, innovation and policy
Neil Bradford and Allison Bramwell

17. INTRODUCTION

The forces of globalization have accelerated over the past 30 years, putting primacy on the relationship between public policy and the competitiveness of regions. In the post-industrial global economy, policy makers across the Organisation for Economic Co-operation and Development (OECD) countries are preoccupied with ways to encourage the growth and development of knowledge-intensive clusters, not just in places where they are already well established but also in those struggling for reinvention in the wake of rapid and tectonic economic change. As well established empirically, anchor firms and start-up activity tends to spatially concentrate in urban regions with the right mix of human capital, amenities and institutional infrastructures: places with strong research and educational institutions, entrepreneurial support and high levels of collaborative capacity for strategic planning have critical advantages over those that don’t (Pike et al., 2006). At the same time, national governments cannot ignore their less well-positioned rural communities or backward areas. Innovation dynamics unfold differently across places and cannot be explained by macro-economic forces and the locational decisions of firms and workers alone. Largely enabled and resourced by governments, a complex mix of formal and informal institutions shapes the context in which economic activity occurs, leaving local policy makers with questions of how to create the right conditions for generating knowledge-intensive regional growth. This institutional dimension draws analytical attention to the multi-level nature of economic innovation and the interplay among different levels of government and multiple public and private sector actors in shaping regional development trajectories.

This chapter brings institutions ‘in’ to the discussion of regional restructuring and innovation. Drawing on multi-disciplinary insights, we find important complementarities between the disciplines of economic geography and political science where the spatial dynamics of economic activity intersect with public policies to shape regional economies. We offer an integrated narrative through three intersecting themes: governance, scale and agency provide an analytical framework for examining the ways in which ‘top-down’ multi-level institutional structures and ‘bottom-up’ associational governance dynamics enable or constrain regional economic innovation. Expressed in a set of development models and policy frameworks informing the ‘New Regionalism’, these themes reflect purposive efforts to move local and regional agglomerations towards globally competitive knowledge-intensive clusters (MacLeod, 2001; Bradford and Wolfe, 2010).

The chapter is organized in two main sections. We begin with a conceptual overview of the institutional dimension of regional innovation, elaborating key theoretical approaches working at – and across – the boundary of economic geography and political science.
Prospects for a more holistic framework are considered along with critical perspectives on normative and methodological aspects of the New Regionalism. We then offer brief public policy illustrations of the ‘ideas in action’, highlighting selected regional innovation programmes underway in the European Union, the United States and Canada.

17.2 SCALE, GOVERNANCE AND AGENCY: THE INSTITUTIONAL DIMENSION OF REGIONAL INNOVATION

Beginning in the 1970s, the forces of globalization and industrial restructuring, coupled with growing concerns about the attendant uneven economic outcomes within and between nations, drew concerted academic and policy attention to the dynamics of regional change. As globalization has accelerated, complexity and turbulence are the permanent backdrop for economic development and issues of regional resilience and adaptability to exogenous shocks acquire salience (Christopherson et al., 2010; Weir et al., 2012). While institutions have long been recognized as critical architectures structuring economic competitiveness and regional innovation, they have received varying levels of analytical attention across disciplines. Each with their own insights on how scale, governance and agency operate and interact, the economic geography and political science literatures on regional economic development are highly complementary but infrequently share insights.

The study of how formal and informal institutions interact to produce novel governance arrangements that operate at multiple levels is a primary preoccupation in political science (Ostrom, 1990; Steinmo et al., 1992; Peters et al., 2005). However, as Gertler (2010, p. 2) observes, institutions remain ‘poorly understood or under-appreciated within much of economic geography’, which tends to focus on how locational decisions of firms shape economic outcomes while underplaying the role of publicly funded infrastructures in these decisions. Public policies reflect conscious and important governmental choices for attracting the flows of ‘people, capital and ideas’ driving regional economic growth (Gertler, 2001). To understand the dynamics of regional economic growth and innovation, the locational decisions of firms need to be considered within this broader institutional and public policy context.

Taking as our starting point the assumption that ‘institutions are crucial for economic development’ (Rodríguez-Pose, 2013, p. 1042), we trace the interplay of three core themes that inform theoretical approaches in the New Regionalism. Governance captures the interaction between ‘hard’ formal rules and state regulations governing economic exchange, on the one hand, and the ‘soft’ institutions comprising local networks and social relations, on the other hand. Scale refers to the multiple, intersecting levels through which these governance relations unfold and link with economic actors and investment flows. Finally, agency underscores the intentionality of these governance and scalar dynamics, and the fact that they are shaped – if not determined – by strategic choices and policy decisions.
Regional economic development became a priority on national government agendas across Europe and North America as evidence of income and opportunity gaps between leading and lagging places began to mount in the late 1950s (Morgan, 1997; Bradford and Wolfe, 2013). In particular, rural and resource-based hinterlands experienced persistently high unemployment rooted in weak educational and literacy rates, economic specialization in industries with declining productivity and outdated physical infrastructure. The resultant dynamic of plant closures and population out-migration led to new political demands for government intervention to stem the losses by equalizing inter-regional opportunities and development outcomes. Soon after, many national governments responded with a variety of strategies and instruments to redevelop structurally backward areas and reduce economic disparities across regions. Assumptions that economic development could be triggered or restarted through government intervention gave rise to relocation policies that targeted individual firms with cost reduction incentives in the form of subsidies, preferential loans and tax concessions, flanked or supplemented by broader public investments in regional infrastructure, such as transportation. In delivering these business inducements and infrastructure investments, national governments typically directed regional development policy in top-down fashion through centralized bureaucratic structures. Local communities and regional actors remained policy-takers with little input into either programme design or service delivery.

The results of such interventions ‘from above’ proved disappointing almost everywhere they were implemented (Rodríguez-Pose, 2013). Despite considerable expenditures, the return on regional development investment was meagre as the programmes failed to reduce inter-regional disparities or even prevent their widening. Explanations for the poor performance were varied and multiple – coordination failures reflecting the absence of connection with local actors, incentives and investments working at cross-purposes often motivating intra-regional bidding wars among communities or municipalities, and an overall emphasis on equalization through redistribution that inhibited indigenous entrepreneurship.

Over the past decade or so, a New Regionalism has taken shape, emerging through research, practice and dialogue across an inter-disciplinary community of scholars, practitioners and policy makers in governments and localities in OECD countries (Asheim, 1996; Cooke and Morgan, 1998; OECD, 2011). Drawing lessons from past failures, the New Regionalism begins from quite different premises about economic development, the role of institutions in change processes and the contributions of government. In this rethinking, three theoretical frameworks have been central to conceptual innovation and empirical research.

17.2.2 Innovation Systems

Emphasizing the broad range of national and regional institutions that interact with social forces to shape the ‘innovativeness of the national economy and society’, the innovation systems literature has been particularly influential in explaining regional economic dynamics and performance (Nieminen and Kaukonen, 2001, p. 5). In this relational and systemic view, innovation results from regular interaction among the specific
components of invention, research and learning that produce, diffuse and adapt new and commercially valuable knowledge (Lundvall, 1992). Fundamental to the innovation systems approach is recognition of the crucial role that knowledge plays in economic growth. The result of a rapidly globalized ‘new economy’ has been not simply a steady stream of new products but the transformation of business organization and the creation of whole new industries processing cognitive and cultural material rather than tangible goods or services (OECD, 1996; Scott, 2012). Such innovation derives from specialized, complex and scientifically intensive knowledge drawn from a wide diversity of fields, and the sharing of less formal ‘tacit knowledge’ that cannot be easily communicated and transferred from firm to firm or place to place (Polanyi, 1962).

It follows that increasing attention is devoted to learning – the building of new competencies and the acquisition of new skills, not just accessing information – as the economy’s most important social process (Lundvall, 1992). With the recognition that existing knowledge assets afford but fleeting competitive advantage, the capability of individual firms to keep pace with the knowledge frontier determines their future success in the global economy. As technology becomes more complex and competition more intense, firms rely on collaborations as a way of managing the escalating risks and costs of knowledge mobilization. Research consortia, cross-licensing agreements, workforce development networks and other collaborative mechanisms are important sources of competitive advantage, helping firms pool resources, access new knowledge, and attract skilled professionals (Rycroft and Kash, 1999). The challenge for government and private, community-based organizations alike is to organize knowledge flows through social learning processes that package the right mix of support in a timely fashion to particular places (Wolfe and Gertler, 2006).

With the view that networked relations are institutionally enabled but also spatially grounded, a parallel stream of work on knowledge networks and regional innovation systems has gained momentum across OECD countries since the late 1980s (Braczyk et al., 1998). Rather than simply administrative jurisdictions entitled to state assistance, regions represent potential ‘innovative milieux’ (Proulx, 1992), a coherent territorially orchestrated set of linked actors, firms and institutions that comprise an innovation system ‘of economic, political and institutional relationships occurring in a given geographic area which generates a collective learning process leading to the rapid diffusion of knowledge and best practice’ (Nauwelaers and Reid, 2005, p.13). Regional innovation policies emphasize the spatial agglomerations of firms according to proximity of knowledge exploration and exploitation activities, linkages between local firms and global knowledge networks, and the crucial role of local and regional institutions in providing the research and human capital infrastructures necessary to develop and anchor emerging innovation-intensive industries (Bathelt et al., 2004).

Drawing attention to national or state/provincial policies and local networking in regional economic development, the innovation systems literature makes two key contributions. First, underscoring the intentionality of the innovation process, it introduces the role of public policy and how decisions to invest in research and human capital infrastructures shape not only the locational decisions of knowledge-intensive firms but, in many ways, their long-term competitiveness and ability to adapt to the vicissitudes of ongoing economic change. Second, underscoring the social or relational dimension of economic performance, the innovation systems literature emphasizes the importance of
of ‘soft’ governance institutions that facilitate the transfer of knowledge and ideas essential to economic innovation (Houghton and Allmendinger, 2008). However, its emphasis on a largely unidirectional and deterministic flow of influence from national policies to regional economies implies a somewhat linear, static and unproblematic set of relations, making it less able to account for several other complex dynamics that influence innovation processes.

17.2.3 Inter-scalar Relations

One of the more influential recent insights in economic geography is the notion that ‘scale’, or the multiple levels at which economic activities and political choices intersect, is both constantly shifting and socially constructed. This perspective examines how ‘locally distinctive and evolving, multiscalar institutional architectures interact with the agency of individuals and organizations to help create particular evolutionary trajectories over time’ that lead, in turn, to different social and economic outcomes across regions (Gertler, 2010, p. 2 [emphasis added]). Through globalization, national institutional scales have been restructured upward to supranational levels and downward to community, urban or regional levels, and in the process, ‘entrenched scalar configurations are continually junked and remade’ (Brenner, 2001, p. 592). Scale is fluid and multi-dimensional, delimiting a complex set of inter-relations between investment location, institutional jurisdictions and the spaces where actors forge networks. In this account, the dynamics of economic growth are social processes embedded in a complex set of relations that operate across, local, national and global scales, while regulatory regimes and sets of public policies that stimulate and regulate economic innovation are formulated in a range of government sites that operate interdependently at multiple levels. Multiple relationships constantly move in multiple directions between and across spatial scales, often intersecting, but just as often colliding and conflicting, or failing altogether to connect (Bunnell and Coe, 2001).

These dynamics unfold at the urban scale in regions where human, physical and financial capital, as well as the knowledge-intensive firms that rely on them, tend to agglomerate (Storper and Scott, 2009). Driven by ‘complex changes in socioeconomic geography and fluxes in scale’, city-regions have begun to play a ‘more prominent role in this multi-scalar context’ with important implications for urban development strategies (Rodríguez-Pose, 2008, p. 1026). The socially constructed nature of regional institutions and the intentionality with which they are established and maintained underscore the agency-centred emphasis of scalar relational approaches; regional governance institutions are the product of collective efforts to influence economic outcomes, including the locational decisions of globally competitive firms (Storper, 2013; Gertler and Wolfe, 2004). This underscores the growing preoccupation of urban policy makers with questions of ‘how to create the right conditions for generating the growth of more knowledge-intensive forms of activity within the context of national and regional innovation systems’ (Wolfe and Bramwell, 2008, p. 180). Viewing regional economic phenomena such as industrial clusters through the lens of ‘nested scales’ reveals collaboration carried out with an eye on the outside world, forcing regions to be ambitious but realistic about what can be achieved while linking local assets and capabilities to external sources of knowledge and value chains (Bunnell and Coe, 2001). From the urban and agency-driven character of
these inter-scalar relations, it follows that variation in innovative capacity leads to uneven outcomes across regions, which implies that those able to position themselves for future growth will reap the benefits while regions with weaker collective capacity will be left behind (Clarke and Gaile, 1998; Simmie and Wood, 2002).

The importance of the scalar perspective to development analysis is its focus on the interconnected or ‘nested’ nature of global economic forces and local relations, and how it compromises the autonomy of nation-states to make meaningful choices about economic and social change (Swyngedouw, 1997; Brenner, 2004). However, while introducing the fluid, multi-dimensional and bi-directional nature of multi-level relations under globalization, the scalar account misses several dynamics critical to understanding the institutional dimension of regional innovation. Not only does its tendency to abstraction detract from its analytical precision and grounding in ‘real world’ policy dynamics, its emphasis on the global-local interface underplays the mediating role that national policy and governing institutions can play. Whether to download social and economic functions to lower scales of governance or to support local economic networks are, in fact, political choices. As such, formal institutional structures remain critical in shaping regional development processes and trajectories. These institutional structures and political dynamics require careful analysis in their own right.

### 17.2.4 Economic Governance

The link between place-specific institutional arrangements and economic performance brings into focus issues of governance, the formation of collaborative institutions at the regional scale and their leveraging through public policy (Barca et al., 2012). The networked production that generates knowledge and drives innovation requires meaningful collaboration among multiple actors, most of whom are more disposed to compete and conduct research ‘in house’ than cooperate or share ‘trade secrets’. Such barriers are rooted in long-standing collective action dilemmas, including the temptation to free ride, the frustration with transaction costs and the risk of defection or exit from ‘talk shops’ (Ostrom, 1990).

Economic governance research sets a twofold agenda: first, to clarify why knowledge-based production justifies the time and trouble of collaboration, and second, to demonstrate how well-designed institutions can help resolve the challenges and disincentives. Market forces undervalue such joint ventures meaning that the various actors require incentives and support to mobilize around a longer-term, transformative agenda. Acknowledging that the mere co-location or spatial concentration of resources does not automatically translate into economic innovation, governance research explores how the latent synergies among ideas and organizations can be realized. Ash Amin has offered an institutional interpretation of governance, combining macro-level economic regulations such as property and human rights or the rule of law – formal institutions typically enforced through state mandate – with informal or ‘soft’ institutions of norms, values and conventions that emerge and evolve through community-driven relationships and networks (Amin, 1999). Governance research specifically highlights interaction and learning originating at two distinctive scales: the regional ‘associational’ and the national ‘multi-level’ scales. It explores how or whether an effective balance can be found between, on the one hand, the national government’s need to provide overall direction and ensure
accountability and, on the other hand, the provision of greater space for innovation through the devolution of responsibility to local and regional partners who will either enjoy the fruits of success or live with the consequences of failure.

The strength of associational governance resides in its concern with embedding public policy in local institutional structures, using dialogue and deliberation to generate shared interpretations of challenges and facilitate mutual learning about collaborative solutions. Amin envisions a ‘reflexive state’ that, while locally embedded through delegated authority to regional partners, retains the capacity to steer processes and coordinate resources (Amin, 1999). Decisions are reached through dialogue, negotiation and local experimentation rather than hierarchical imposition of authority as innovations in the knowledge-driven economy are never simply the result of legislative mandates or administrative actions (Bradford and Bramwell, 2014).

Complementing the associational approach, scholars of multi-level governance investigate new institutional architectures where political authority and policy influence are dispersed across the different levels of the state and an array of public-private agencies (Hooghe and Marks, 2001). No one level or organization exercises unilateral authority and formal constitutional power allocations are often set aside in favour of more pragmatic ‘join-ups’ where roles and responsibilities are assigned on a case-by-case basis in relation to the particular policy challenges – and local places – under consideration. Rather than layering new programmes on existing ones in a disjointed fashion, governments need coordination ‘from below’ through intermediary institutions ranging from local government to business associations or voluntary sector networks that convene actors and channel resources. While this approach does not eschew national investments in physical or research infrastructures, it asserts that realizing their innovation potential depends on the ‘fit’ with local or regional priorities as these are shaped by the efficacy of community-based networks in transmitting ideas, connecting actors, and delivering services. Through their own organizational networks and institutional relations, local actors define the optimal geographic scale for development and the appropriate mix of innovation support. From the economic governance perspective, whether and how government interventions are targeted to unique gaps in regional innovation systems becomes a benchmark for measuring public policy performance (Savitch and Kantor, 2002).

17.2.5 Toward a Synthesis

Each of these three influential literatures on regional economic development enters the innovation discussion through a distinct intellectual frame. However, there emerges a shared emphasis on how national and supranational institutions, public policies and governance relations operating at multiple scales interact to enable or constrain economic development processes and innovation trajectories. While global macro-economic forces, national innovation systems and macro-institutional structures are seen to provide the regulatory frameworks and public investments that shape the environment in which firms operate, the critical arena of action is the regional one. All three approaches coalesce on this point: what matters most for innovation performance in the knowledge-based global economy is the form, nature and capacity of localized networks and governance institutions to exploit territorial synergies, leverage external resources and align multi-level forces and flows. Emphasizing local and regional variation, these literatures acknowledge
alternative outcomes and different ‘imaginaries’ (Scott, 2007), as development paths follow unique and place-specific interactions among national and regional innovation systems, multi-scalar relations, and national and sub-national governance institutions and policies. In this agency-centred view, regions can make strategic choices and take consequential action in relation to their economic futures. Adaptive and collaborative governance arrangements animated by engaged public, private and community-based leadership and facilitated by institutional intermediaries reflect a sort of ‘local genius’ that sets innovative regions apart (Henton et al., 1997; Safford, 2009; Storper, 2013).

Combining the insights of these theoretical traditions crossing economic geography and political science, the New Regionalism recasts development and innovation as the ‘strategic management of places’ (Audretsch, 2003). Through multi-level institutional analysis, the New Regionalism connects issues of scale, governance and agency. The resulting synthesis has several distinguishing intellectual and policy-relevant features.

17.2.5.1 Clusters and regional innovation systems

The foundation for success in the knowledge-based global economy resides in businesses that generate high value-added goods and services to become leaders in the marketplace. Such firms must invest in their knowledge assets such as worker skills, technological capabilities and logistics and distribution. To stay ahead of the competition, firms can benefit from geographical co-location if they exploit the available synergies among organizations and policies. In some places the specific priority might be upgrading traditional manufacturing, in others diversifying resource-based economies or growing leading-edge technology firms. Clusters grow in regional innovation systems that blend different forms of knowledge in partnerships joining industry and educational institutions, venture capitalists and commercialization incubators, anchor firms and start-ups, and skills centres and business associations. Such synergies help translate new ideas into marketable products, and clusters can take the form of both high-technology concentrations of firms, which often centre around research-intensive universities or institutes, as well as those based in older industries applying knowledge to transform traditional products and processes. Cluster-building dynamics are central to the economics of the New Regionalism, making it easier for firms to access ideas, source parts, recruit talent, and for communities to attract public investment in the infrastructure of innovation (Wolfe, 2009).

17.2.5.2 Place-based policy and multi-level governance

There is no automatic process or linear pathway that connects the worlds of research, commercialization and business. Regional innovation systems that grow clusters do not pop up anywhere. Governments must invest in the knowledge infrastructure, catalyse networks and enable local actors to sustain their innovative milieux. Devolving authority to the geographic scale, where organizational synergies and policy interdependencies play out, helps governments align their investments with local priorities. Such targeted intervention is now known as place-based policy and its close attention to context and community is central to the multi-level governance of the New Regionalism. Sector-based policies alone do not address the need for links between different interventions. For example, human capital – through a programme to enhance skills – should match the needs of emerging industries; and a strategy to increase the attractiveness of a place for investors has to take into account social, cultural and legal issues in addition to purely...
economic considerations. National, provincial or state governments have the resources to establish territorially based innovation and investment for business development, knowledge deepening and capacity building. But these macro-level offerings must connect with community-based networks articulating specific priorities and their interconnections. The place-based, multi-level governance approach to economic development has been promoted by the OECD, the European Commission and both the American and Canadian federal governments (Barca et al., 2012).

17.2.5.3 Policy learning and knowledge transfer
A unifying theme in the New Regionalism is the importance of knowledge, whether for firms seeking to innovate, communities mapping their assets or governments exploring how to work together. There are four specific ways in which social learning is integral to innovation. First, there is a need for systematic analysis of local and regional economies, learning from past successes and failures, connecting these to their evolving comparative advantages and emergent investment opportunities. Second, recognizing that there are no cookie cutter templates in place-based approaches, good policy depends on research that tracks which strategies and tools work best, where and why. Third, given the long-term nature of regional development, the multiple actors engaged and the uncertainty of policy impacts, evaluation is a key priority. New Regionalism research is developing indicator systems to benchmark progress, specify outcomes and institutionalize feedback loops to inform programme adjustment and policy change. The most dynamic and resilient regions are expert in local social knowledge management that enables communities to cultivate their assets, undertake collaborative change and embed a collective mindset fostering innovation. They move beyond ‘a transactional culture, which is obsessed with process and compliance issues, to a transformational culture which is outcome-oriented and informed by the place-based policy paradigm’ (Morgan, 2013, p. 120).

17.3 REGIONAL INNOVATION: THEORY MEETS PRACTICE THROUGH POLICY
The New Regionalism has acquired substantial influence in research and policy circles. With such interest comes scrutiny (Lovering, 1999; Hadjimichalis, 2006). The 2008 global recession’s legacy of deepening economic disparities has brought key theoretical constructs and practical assumptions into question (OECD, 2014). Remaining in many ways a bold policy experiment, the New Regionalism’s long time horizons for measurable economic and employment progress may compromise its political viability. Sustaining long-term public investments requires ongoing policy and programme evaluation, which, in turn, demands conceptual clarity of the policy ideas on which performance benchmarks are premised. One influential critique of the New Regionalism identifies ‘fuzzy concepts’ applied without definitional precision and used indiscriminately to explain diverse and distinct dynamics (Markusen, 1999; Hudson, 2003). Concepts such as ‘institutional thickness’, ‘social learning’ or ‘untraded interdependencies’ are all highly suggestive but also analytically elusive. They point to a range of social dynamics difficult to empirically specify or translate into causal accounts of change. A formative assumption of the New
Regionalism is that ‘hard’ or formal governmental institutions interact with informal or ‘soft’ institutions and processes to drive economic innovation. However, soft institutionalism used interchangeably to refer to background norms and collective identities, as well as novel forms of associative governance, may conflate variables and limit analytical clarity.

Such concerns speak directly to the frequently heard charge of ‘fast policy transfer’ (Lovering, 1999; Peck, 2011). Institution building and networked relations may be necessary for regional innovation, but the public policy case – and intervention tools – are both much less straightforward than for traditional public investments in infrastructure, education or research. Questions about the appropriate form, scope and scale of institutional support abound, especially in relation to variation in capacities and needs across different types of regions. Dysfunctional mismatches between public policy and local context rooted in ‘widespread vagueness about the subject’ risk squandering public funds (Farole et al., 2009, p.12). Moreover, the New Regionalism is ambitious in its vision, incorporating views of innovation beyond simply business processes and products to include social transformations that link economic and ecological priorities or that include ‘place making’ connecting innovation to quality of life and equity (Pastor et al., 2000).

Here, the New Regionalism’s treatment of the state has been viewed as particularly inadequate. The turn to informal or voluntary governance relations implies a ‘hollowing out’ of state power allowing regional elites to focus narrowly on their priorities or exclude diverse community voices in economic planning (Jessop, 2004). Institutional ‘lock-in’ is the dark side of regional development powered by face-to-face interaction and networked relations. Whether and how innovation flows from ‘institutional thickness’ remains a significant empirical question, one that the New Regionalism tends to downplay in its vision of localized collaboration as the most responsive mode of governance for the knowledge-based economy. The appropriate balance between ‘state steering and regional rowing’ remains a research priority.

While scholars continue to debate and explore the New Regionalism, it is clear that the ideas are resonating with policy makers across the OECD and beyond. Illustrative of the influence are experiences from three jurisdictions – Canada, the European Union and the United States – all of which have long histories with regional economic development. Each jurisdiction exhibits a similar regional development trajectory, moving from initial emphasis on centralized redistribution and equalization towards support for innovation through institutional collaboration and place-based policy.

17.3.1 European Union: Smart Specialization

Regional development policy in Europe has long been marked by emphasis on redistribution and equalization. Beginning in the 1990s, the European Union (EU) dedicated part of its regional development fund to address the technological deficit of less favoured regions as part of a broader innovation thrust that included cross-border cooperation, urban revitalization and industrial restructuring. This direction was confirmed in the early 2000s when the overall development focus shifted from redistribution from richer member states to poorer ones, towards emphasis on enhancing the international competitiveness of the EU as a whole through innovation in all regions (Wolfe, 2010). To facilitate implementation of the more contextualized, bottom-up strategies, the EU devolved
policy authority to regional scales and supported local actors in mobilizing networks and setting priorities for global competitiveness.

Central to the reorientation is the concept of ‘smart specialization’ that signals a new era of regional innovation policy in the EU (Morgan, 2013). Described as ‘a tool for regional policy’ that follows the ‘place based approach’ promoted by the European Commission and the OECD (European Commission, 2012, p. 16; see also Barca, 2009), smart specialization envisions ‘a role for every region’. Smart specialization builds on three concepts: embeddedness, related variety and key enabling technologies. Embeddedness acknowledges path dependency in regional development, focusing initial renewal effort on industries with existing advantages. With related variety, however, investments in the regional knowledge base allow for ‘specialized diversification’ as technologies and networks applied in established sectors can be adapted to complementary ones in the value chain. Regions reposition themselves through key enabling technologies (for example, semiconductors, photonics, biotechnology and nanotechnology) that drive economic transformation. While not all regions will be leaders in developing such technologies, all regions can make specific applications of a key enabling technology to improve industries along the value chain. Smart specialization places equal emphasis on radical innovation through research-based scientific breakthroughs and on practice-based adaptations that deliver incremental innovations over time.

Smart specialization works through an ‘entrepreneurial process of discovery’ wherein broad coalitions of firms, educators, researchers and financiers are empowered to identify the domains of innovation that will be EU investment priorities (Foray and Goenaga, 2013). Funding flows to those specializations that both reflect regional knowledge assets and productive advantages and also project strongly as viable competitive platforms for the region’s longer-term future. According to Dominique Foray, ‘Prioritization is no longer the role of the omniscient planner but involves an interactive process, in which the private sector is discovering and producing information about new activities and the government assesses potential and then empowers those actors most capable of realizing the potential’ (Foray, 2013, p. 4). To qualify for EU financial support, regions must prepare strategies that specify objectives, indicators and outcomes from the outset. Systematic use of peer review allows regions to learn from one another about strategy formulation and implementation challenges, while also helping to broker potential inter-regional partnerships that drive specialized diversification. With smart specialization, the peer review process is formalized as each exercise proceeds in three stages – presentation of regional strategy; interactive workshops producing feedback commentary from peer regions and independent experts; and there is a post-review follow-up when the reviewed region reports progress. Overall, the EU has taken a comprehensive approach to evaluation, using various tools to align behaviour at the regional and state levels, and to make evidence-based adjustments in strategies. Evaluation thus becomes more learning about what works where than punishing non-compliance with mandates or directives.

17.3.2 United States: Innovation Ecosystems

With its highly decentralized and uncoordinated institutional structures, the United States stands out as one of the few Western industrialized countries to lack a comprehensive national innovation policy. Yet, with its world class research universities and multiple
commercialization and technology transfer mechanisms, it remains one of the most innovative knowledge-intensive economies in the world (Hepburn et al., 2012). Because federal innovation policies and programmes are typically fragmented, financially meagre and of insufficient duration to achieve measurable economic outcomes, to date virtually all initiatives to actively promote regional innovation have taken place at state and local levels (Wessner, 2013). However, recent activism to reduce regional disparities by stimulating innovation in selected sectors indicates important policy evolutions at both state and federal levels.

Based on an emerging consensus that knowledge-intensive clusters tend to emerge organically with the right support in place rather than by policy dictate, many states have begun to augment traditional, linear technology transfer models that target particular sectors with more holistic ‘innovation ecosystem’ models. Better integrating the underlying factors supporting regional innovation to facilitate more agile responses to shifting technology and market conditions, these ‘hubs’ or ‘communities of innovation’ enable ongoing collaboration and knowledge-sharing among industry associations, universities, large research-driven firms, entrepreneurial start-ups and investors located in a particular region regardless of the industrial sector to which they belong (Wolfe, 2009). Notable examples include semiconductors and nanotechnology in New York, wind energy in Arkansas and flexible electronics and photovoltaics in Ohio. With the intent of encouraging both new entrepreneurial activities as well as building on existing specializations, some states are beginning to achieve ‘impressive results in building innovation-led industries with bold and comprehensive strategies’ (Wessner and Wolfe, 2012, p. 36).

In the wake of the recent recession, a shift to more holistic and integrated approaches has also emerged at the federal level to augment state-driven innovation efforts. Building on the regionally targeted stimulus programme of the American Reinvestment and Recovery Act (ARRA) of 2009, and capitalizing on the growing political feasibility of supporting a ‘manufacturing renaissance’ in the United States, a policy consensus has begun to form around the need for ‘new model innovation agencies’ (Bonvillian, 2014). Inspired by integrated European technology transfer models, the National Network of Manufacturing Institutes (NNMI) has recently been established under the Obama Administration to encourage innovation, technology transfer and commercialization in several areas of knowledge-intensive advanced manufacturing (Hauser, 2010). These regionally anchored multi-agency ‘innovation hubs’ are intended to provide a bridge across the ‘valley of death’ between research and development (R&D) and new technology adoption, to develop relevant workforce skills, and to facilitate firm access to publicly funded research and equipment necessary to commercialize new product and process innovations (White House, 2013).

Structurally, the NNMI consists of Institutes for Manufacturing Innovation (IMIs), each of which is comprised of an industry-led consortium that includes academic and government representatives who are expected to work collaboratively and to co-invest in resources. Similar to their European counterparts, each IMI is unique, positioned to build on existing regional assets and capacities in their respective regions while also sharing knowledge with the other institutions in the network (NNMI, 2013; Sargent, 2014). The creation of 15 regional IMIs announced in the 2013 State of the Union address was quickly followed by a proposal to expand the network to 45 IMIs within the next ten years. The four institutes established to date include: the National
Additive Manufacturing Innovation Institute (NAMII), now known as America Makes, in Youngstown, Ohio, focused on additive manufacturing (also known as 3D printing); the Next Generation Power Electronics Manufacturing Innovation Institute, at North Carolina State University in Raleigh that will focus on energy-efficient, high-power electronic chips; the Digital Manufacturing and Design Innovation Institute (DMDI) in Chicago, led by UI Labs, that will develop supply chain interoperability and digital capabilities to design and test new products; and the Lightweight and Modern Metals and Manufacturing Institute (LM3I) in Detroit that will develop production processes for strong, lightweight alloys for multiple industrial applications.

17.3.3 Canada: Institutional Intermediaries

In the 1980s, the theory and practice of regional economic development in Canada were overhauled. Rather than aiming to eliminate inter-regional disparities through general incentives and top-down investments, the purpose became to enable all regions – remote, rural and urban – to generate transformative visions, identify priority projects and assemble the particular mix of support required for progress. Institutional innovation was central to this reorientation in goals and practices and it came in the form of a national network of regional development intermediaries (Bradford and Wolfe, 2012). In a complex federation with shared jurisdiction for economic development and innovation, questions persist about how the different levels of government coordinate. Beginning in the late 1980s, the challenge was given to a national network of four (later expanded to six) Regional Development Agencies (RDAs) mandated to translate federal development goals into regional and community settings, while also promoting those same sub-national interests in federal policy making (OECD, 2007).

The RDAs have been leaders in associational and multi-level governance, making creative use of what the OECD terms ‘relational contracts’ for coordinating the actions of several governments and multiple organizations in joint projects ranging from infrastructure supply to urban revitalization and rural clustering. In executing their mandate, each RDA deploys various policy tools, producing region-specific ‘instrument mixes’. Expenditures in the form of conditional transfer payments to private businesses, non-profit organizations and other levels of government are targeted to finance promising development initiatives that would otherwise have been postponed or abandoned if left solely to the market. The RDAs have been active in knowledge mobilization, reporting on regional-specific trends and priorities, often in partnership with research institutes and business associations. More ambitiously, RDAs also support local and regional governance innovations. In rural Canada, the RDAs work through a national network of over 250 ‘community futures’ economic development corporations that mobilize volunteer boards of directors to manage business services, investment funds and regional plans. In urban settings, the RDAs have negotiated ‘urban development agreements’ among the three levels of government producing innovations at the intersection of economic and social priorities, including community development for the social economy in Quebec and British Columbia and university-business knowledge transfer for technology cluster formation in Atlantic Canada and Ontario. As institutional intermediaries, the RDAs have garnered recognition: the community futures network was ‘singled out by the OECD as one of the most innovative and successful rural-oriented policies anywhere in the world’
(Standing Senate Committee on Agriculture and Forestry, 2008) and urban development agreements in Vancouver and Winnipeg received both national and international governance awards.

Canada’s RDAs remain interesting policy and governance experiments (Conteh, 2013). In existence for nearly three decades, they blend traditional firm-oriented policy instruments with several leading-edge governance tools for community capacity building and regional innovation systems. They supply a national policy focal point for multi-level governance – supporting the actors, negotiating framework agreements, contributing financially and monitoring progress. Marshalling the evidence base to support this federal regional policy and place-based governance niche has not been straightforward. Assessments from the Auditor General of Canada and other evaluators point to the absence of specific measurable outcomes for programmes, lack of criteria to ascertain the business impacts of non-commercial partnerships and uncertainty about the return on investments in network or capacity building (Auditor General of Canada, 2001). These issues loom large as the RDAs transition from their ‘shovel ready’ anti-global recession job creation agenda to supporting longer-term economic transformation and community innovation. Evaluation is an integral part of the policy learning process, and developing appropriate metrics or indicators to benchmark and assess performance remains a significant regional economic development challenge in Canada.

17.4 CONCLUSION

This chapter has explored the issues and challenges of regional development in the context of the global knowledge-based economy. Drawing relevant insights across the disciplines of political science and economic geography, it proposes an integrated analytical framework for studying regional economic change built around the core concepts of scale, governance and agency. Framed by renewed attention to institutions at multiple levels, the chapter emphasizes the interactive nature of the innovation process as various actors mobilize resources for regional collaboration to support economic clusters and community resilience. Acknowledging the interplay of theory and practice characterizing the New Regionalism, the chapter reviews critical perspectives on such boundary crossing as well as recent public policy initiatives in three jurisdictions long known for government engagement with problems of regional decline and renewal. From both scholarly and practical perspectives, the chapter demonstrates that the New Regionalism is ‘a work in progress’. A growing body of case study research continues to inform robust theoretical debate about institutions and agents of regional development while state programming provides rich opportunities for learning ‘what works where and why’. At the crossroads of academic and applied analysis, the field of regional economic development remains a vital space for intellectual exploration and policy experimentation.

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18. Revisiting the role of policy in regional innovation systems

Elvira Uyarra and Kieron Flanagan

18.1 INTRODUCTION

The continued interest of academics and policy makers alike in understanding and replicating the vibrancy of innovation hotspots such as Silicon Valley has given rise to an extensive body of research into regional innovation dynamics, the drivers and preconditions for knowledge-driven economic development and – inspired by these insights – the tools policy makers might use to drive, support or enhance these processes. However, transplanting conceptual insights into policy has arguably been met with variable success. In this chapter we review scholarly thinking about regional systems, regional path creation and resilience, and about the roles of public policy in all this, in order to understand where policy prescriptions have come from and what the prospects are for more effective prescriptions in the future. We argue that a better understanding of the development of places and the potential for policy to aid in that development requires a better understanding of policy interventions and policy processes as they play out in the development of places. In what follows, we identify some shortcomings in existing approaches and the elements of an alternative approach that might be better suited to developing such an understanding. The chapter thus proceeds as follows. After a brief section introducing the role of institutions and policy in regional innovation system views, we outline recent approaches seeking to understand the dynamics of transformation of regional economies and their associated policy implications. The chapter then moves on to discuss the role of policy in regional path creation and argues for a need to better incorporate the role of social agency in relation to processes of change, including institutionalization. The final section presents some conclusions and reflections.

18.2 INSTITUTIONAL VIEWS OF REGIONAL INNOVATION SYSTEMS

From the 1990s, concepts such as clusters, learning regions and regional systems of innovation (RSI) have foregrounded the role of regions as engines of innovation and growth. These insights were informed by detailed studies of a number of European industrial regions felt to be functioning as innovation systems, that is, ‘geographically defined, administratively supported arrangements of innovative networks and institutions’ (Cooke and Schienstock, 2000, p. 273). Economic success in these places was felt to be underpinned not only by the presence of a network of supporting institutions and a significant concentration of firms but also by the degree of ‘embeddedness’ and ‘institutional thickness’ of the resulting whole (Amin and Thrift, 1995) and by a high
degree of shared social and cultural values, or relational assets (Doloreux, 2002). Spatial
proximity was seen as a prerequisite to the development of these relational assets (Cooke
and Morgan, 1998).

Indeed, research on regional innovation dynamics has exerted a great deal of influence
on public policy. This is partly explained by the ‘fuzziness’ (see Markusen, 1999) and
interpretive flexibility of terms such as ‘cluster’ or ‘regional innovation system’, which
makes them attractive ‘boundary objects’ around which actors with very different under-
standings and interests can nonetheless come together (Uyarra and Flanagan, 2010).
However, there is also an underlying prescriptive bias in much of the source literature,
which is prone to collapsing ‘levels of abstraction into simple narratives to render them
digestible for politicians and policy-makers’ (Morgan, 2004, p. 873) and to overstating the
capacity for policy action at the regional level.

The ‘canonical’ or institutional interpretation of RSI has been criticized for a closed
view of systems that assumed that more or less fixed boundaries could be set around the
system and that system actors and their activities could be straightforwardly identified
and acted upon by public policy (Uyarra, 2010). Regional innovation system thinking, in
particular, often comes with an assumption not only that regional-level interventions can
in principle enhance the ‘systemness’ of the system but also that in practice the necessary
resources, capacity and levers are likely to be available at the regional level (Uyarra and
Flanagan, 2010). RSI inspired policies thus often exhibit an ‘autarkic vision of innova-
tion, confined to the regional boundaries’ (Nauwelaers, 2011, p. 479). Yet regions are no
more closed policy systems than they are closed innovation systems, and an awareness
of the levers available to policy makers at different levels of governance is key to ena-
bling more realistic and better targeted policy actions. Elsewhere (Uyarra and Flanagan,
2010), we examined the policy mix for innovation in the North West of England, where
innovation patterns were mainly affected by the impact on the region of past and present
national science and innovation policies and – perhaps to an even greater degree – by
other national policies such as health, energy and defence, to the point where the modest
regional innovation policy efforts of the time were in large part about dealing with the
consequences of such impacts.

Moreover, by focusing on the study of successful regions, economic geographers
tended to overemphasize the importance of strong local embeddedness and ‘institutional
thickness’ and provide a static depiction of successful regions without a deeper consid-
eration of how sectors, actors and institutions emerge and transform over time. The
‘institutional turn’ (Amin and Thrift, 1995) focused on how inherited institutional frame-
works shaped the ability of places to respond to the pressures of globalization. But insti-
tutions are geography and sector-specific, meaning that similar arrangements may lead
to different outcomes in different settings and, conversely, that very different institutional
contexts may yield similar economic results (Rodríguez-Pose, 2013). Furthermore, insti-
tutions evolve over time and may contribute towards inertia and lock-in (Grabher, 1993).
For these reasons it is likely to be risky to uncritically compare ‘systems’ or seek to draw
simple policy lessons from other systems. However, despite frequent exhortations about
the need for adapted and context-sensitive policies, the mimetic adoption of recipes that
seem to have worked elsewhere remains all too common.
18.3 EVOLUTIONARY ECONOMIC GEOGRAPHY VIEWS OF REGIONAL PATH DEPENDENCE

Reacting to the limitations of previous approaches, more recent contributions to the geography of innovation, particularly by scholars within the evolutionary economic geography school (see, for example, Boschma and Martin, 2010; Kogler, 2015), provide a reinterpretation of regional innovation systems, trying to understand how some regions are able to renew and sustain growth while others decline. Drawing on insights from evolutionary biology, complexity theory and network science, evolutionary economic geographers attempt to link the micro-economic behaviour of agents (firms, individuals) that operate in territorial contexts with the spatial evolution of industries and networks at the meso-level of the economy.

Evolutionary interpretations have revisited traditional ideas of path dependency in order to understand processes of regional evolution and lock-in. Henning et al. (2013) situates the debate on regional path dependence along two dimensions, namely, the emphasis on industrial continuity in path dependence (as opposed to greater locational freedom of new industries) and the extent to which external shocks are needed to establish new paths. Evolutionary economic geography approaches consider that the uneven geography of new path formation is best understood by seeing regional path dependence as a branching process of industrial development triggered by endogenous processes of structural change as opposed to exogenously driven or ‘accidental’ shocks. Empirical research on ‘related variety’ and regional branching suggests that countries and regions are more likely to branch out (diversify) into technologically related industries than into any new industry (Frenken et al., 2007; Neffke et al., 2011). Knowledge transfer from old to new sectors is in turn enabled by locally embedded mechanisms, including spin-off processes, firm diversification, mobility of employees or the formation of innovation networks (Boschma and Frenken, 2011). This has parallels with views on industrial policy emphasizing the role of entrepreneurial discovery (Hausmann and Rodrik, 2003).

Evolutionary geographers, particularly of the so-called ‘Dutch school’, focus on local processes of reproduction of firm-level routines leading to unintended, aggregated effects at the meso-level, informed by Nelson and Winter’s (1982) evolutionary theory of the firm. They suggest a divide between institutional economic geography and evolutionary economic geography, arguing that institutions are ‘orthogonal’ to organizational routines (Boschma and Frenken, 2009). Other views, by contrast, see this division as artificial (Essletzbichler, 2010), suggesting the need to restate the role of institutions and social agency (MacKinnon et al., 2009) and acknowledge not just the influence of disembodied economic forces in path creation but also that of knowledgeable agents (Simmie, 2012; Simmie et al., 2014) ‘mindfully deviating’ (Garud and Karnøe, 2001) from existing social practices and artefacts.

In this vein, Martin and Sunley (2006) propose a dynamic ‘path as process’ view, understood as ‘an on-going, never ending interplay of path dependence, path creation and path destruction that occurs as actors in different arenas reproduce, mindfully deviate from, and transform existing socio-economic-technological structures, socio-economic practices and development paths’ (p. 408). Dynamic ‘path as process’ views of path creation allow for a wider repertoire of options in the evolution of technologies, industries and regional economies. Martin and Sunley (2006) propose several such scenarios
of path development and renewal (or ‘de-locking’), including the upgrading of a mature path, diversification through exploiting synergies between an existing path and a new one, and new path creation.

18.4 POLICY IMPLICATIONS OF EVOLUTIONARY APPROACHES

Unlike the literature on regional innovation systems and other territorial innovation models, the new evolutionary approaches do not offer strong policy prescriptions. Work on related variety (Frenken et al., 2007) highlights the importance of related diversification for a region’s ability to adapt to changing conditions and grow. In order to increase the likelihood of the emergence of new growth paths, public policies should foster the emergence of industries that are technologically related. Policies supporting relatedness would, according to Boschma and Giannelle (2014), include instruments that favour entrepreneurship, with a focus on experienced entrepreneurs, labour mobility (particularly between related industries) and collaborative networks with partners in different – but related – industries.

Cooke (2013) similarly proposes policies promoting ‘transversality’, that is, the active identification of ‘structural holes’ between disparate but related knowledge fields and effective policies that can enable relatedness and exploration of the ‘adjacent possible’ (Kauffman, 1993) through knowledge recombination. This implies a shift in policies from narrowly conceived ‘clusters’ to ‘regional innovation platforms’, defined as ‘regional resource configurations based on the past development trajectories but presenting the future potential to produce competitive advantage’ (Harmaakorpi, 2006, p.1089). It has been suggested that platform policies offer greater potential for innovation than traditionally conceived ‘one size fits all’ cluster policies, since they encourage cross-fertilization of different ideas and practices among firms in the same or different industries (Cooke, 2012). Platform policies to support related variety are also a core component of the Constructing Regional Advantage (CRA) policy model (see also European Commission, 2006; Asheim et al., 2011). This model suggests that innovation is strongly shaped by the specific knowledge base of activities and their combinations in regions, underlying the importance of tailor-made policies that support industries based on their degree of technological relatedness with other industries in the region, in order to favour new combinations and new variety in the region.

This emphasis on transversality and relatedness resonates with recent approaches to cluster policy that call for a more ‘surgical’ type of intervention (Crespo et al, 2014), more centred on network renewal (Tödtling and Tripl, 2004) and better attuned to the life cycle of clusters (Menzel and Fornahl, 2010). Abetted by methodological advances in the understanding of the dynamics of networks, geographers have proposed a more fine-grained understanding of the evolving configurations of industrial networks and their influence on the performance and resilience of regional economies (Giuliani, 2007). Over time, network formation mechanisms such as closure and preferential attachment mean that clusters tend to evolve from loose structures into more highly connected ones, dominated by a few hubs and oligopolistic organizations. In other words, clusters may improve their degree of adaptation to regional conditions at the expense of reduced adaptability.
to future economic shocks (Grabher and Stark, 1997). This process of concentration and specialization eventually leads to cognitive and functional lock-ins (Grabher, 1993). Whereas traditional cluster policies tend to assume that ‘networks are good, more networks are better’ (Freel, 2003, p. 766), Crespo et al. (2014) argue that cluster interventions require bridging strategies between the core and periphery of nodes, in order to allow for new and disruptive ideas that can favour resilience.

The smart specialization approach recently advocated by the European Commission (2012) combines some of these insights and places the focus on the identification by regional policy makers of existing or potential competitive advantages, from which they can diversify. However, how to identify these priorities and how exactly such smart specialization should be pursued in practice (Landabaso, 2014) remains the focus of considerable debate. Smart specialization is, in the words of Foray et al. (2011, p. 1), ‘a policy running ahead of theory’, very quickly becoming influential in the policy world despite lacking both a sound base of empirical work and well-developed policy instruments to support its implementation (Foray et al., 2011).

18.5 TOWARDS AN EVOLUTIONARY VIEW OF POLICY IN PATH CREATION

We have described how insights from evolutionary economic geography, underpinned by concepts of path dependency and industry evolution, have provided more dynamic interpretations of regional systems and led to a more nuanced policy discourse about adaptive, place-based and ‘outward looking’ interventions. Evolutionary approaches also acknowledge that there are limits to policy action, in terms of the degrees of freedom policy makers have to influence the future development of regions in an evolutionary context (Lambooy and Boschma, 2001).

However, despite this progress, consideration of policy still tends to be confined to the normative question of policy implications (Wohlgemuth, 2002). Policy is rarely seen as embedded in and shaping the creation of new paths. The recent focus on firm-led regional branching approaches has tended to neglect the role of institutions in general, and the role of policy in path creation in particular (Morgan, 2013; Uyarra and Flanagan, 2013; Dawley, 2014). This, according to Essletzbichler (2012, p. 187), risks providing a ‘rather impoverished treatment of space’. MacKinnon et al. (2009) further argue there is a need to reassert place-specific institutional environments and arrangements within and beyond firms, including ‘deliberate intervention through public institutions such as the state’ and to situate evolutionary concepts within a broader geographical political economy. For Martin and Sunley (2011) place is important not just as a result of entrepreneurial variety generation but also in terms of processes of collective support (including policy support) and the selection and emergence of new trajectories.

Essletzbichler (2012) distinguishes between regions as selection units and as multi-scalar selection environments. Regional actors and their networks, as well as institutions, form part of the regional selection environment and can act to constrain (or enable) choices at the local scale. This involves the possibility of path creation being the product or by-product of purposive action by economic agents (Sydow et al., 2010) consciously or inadvertently contributing to shaping the selection environment (Essletzbichler, 2012).
In this multi-scalar view, upward and downward causation operate simultaneously, in that evolution at one geographical scale is linked and influenced, but not determined, by evolution at other scales (Essletzbichler, 2012; Uyarra and Flanagan, 2010).

To illustrate, Dawley (2014) examines the way in which local institutional agents in the North East of England shaped their position and relationships within multi-scalar institutional environments and frameworks and their key role in identifying, harnessing and matching regional assets to new market opportunities in offshore wind power generation as part of path creation. Fornahl et al. (2012) similarly describe how policy makers in Bremen deliberately tried to influence framework conditions to enable path creation and development in the offshore wind sector. Gee and Uyarra (2013) trace a process of system transformation of a metropolitan waste management system, where a policy entrepreneur influenced framework conditions in terms of institutional incentive structures, social perceptions and regulatory frameworks at local and national scales to favour the selection of an alternative, more sustainable technological solution that would shift existing paths.

These examples point to the importance of acknowledging that strategic or deliberate action can influence conditions for path creation and development (Essletzbichler, 2012; Simmie, 2012; Dawley, 2014) and incorporating this into a broader understanding of agency and entrepreneurial discovery processes in regional innovation. The role of the state in path development may be particularly relevant when considering peripheral regions that have long been the focus of state-led policies to support institutional change (Dawley, 2014); where the state has played a strong role in industry emergence by acting as first client or user of a new technology; or when considering the emergence of industries around niche environmental technologies that owe their development to public sector incentives (Simmie, 2012; Mazzucato, 2013; Morgan, 2013).

Indeed, studies on environmental technologies and sustainable sociotechnical transitions have shown that markets for environmental technologies are highly dependent on government intervention and that ‘the transformation of socio-technical systems to more sustainable states is more policy induced than market driven’ (Gee and Uyarra, 2013, p. 1175). Many such studies adopt a technological innovation systems approach (for example, Bergek et al., 2008), which identifies a series of functions associated with the development and diffusion of a new technology. This approach emphasizes the importance of enabling, through policy intervention, an institutional context that is supportive of the emergence of clean technology industries, including specific interventions that address systemic failures or perceived gaps in terms of the activities performed in the system. These frameworks have been used to complement evolutionary economic geography analysis of the role of territory-specific institutions in the emergence of particular industries (for example, Martin and Coenen’s, 2014 study on the biofuel cluster in Southern Sweden).

However, these approaches remain problematic with respect to institutions and policy. Besides the implicit or explicit functionalism (also common to many systems of innovation and varieties of capitalism approaches) in which institutions and arrangements are treated as if they evolved and exist in order to perform a systemic function, these perspectives favour a linear and mechanistic view of policy in which gaps in the system are automatically mapped onto policy interventions, and where implementation is viewed as unproblematic. Morgan (2013, p. 337), for instance, notes a tendency of these
approaches to make heroic assumptions about ‘the state as competent and benign actor in the innovation process’ and thus downplay the multiple pitfalls and ‘perils of state-led path creation’.

By not acknowledging the gap between institutions and policies and the way they may be interpreted and/or implemented (a gap that often determines whether policies fail or succeed) such views exclude the possibility of agency and political conflict in public policy (Streeck and Thelen, 2005). It is important, then, not to ignore the ‘messy policy realities that can disrupt proposed policy solutions to market or system failures, and prevent innovation-based growth’ (Mastroeni et al., 2013, p.10). For instance, while it is implicitly assumed that the failure of earlier generations of European Union regional innovation policies was due to misguided rationales informing these policies (namely, that they were too inward looking or too supply-driven or not sufficiently adaptive to changing conditions), more fundamental issues arguably relate to implementation challenges (Uyarra and Flanagan, 2013) and to the risk of capture by political elites (McCann and Ortega-Argilès, 2015; Morgan, 2013).

Perhaps unsurprisingly, a recent meta-evaluation of innovation instruments (Edler et al., 2013) demonstrates that there is no convincing evidence that any of the classes of innovation policy instrument considered in the study ‘works’ consistently in different times and places. In the case of cluster policy, Uyarra and Ramlogan (2016) found wide differences in policy outcomes, resulting from differences in objectives, instrument choice and implementation styles associated with the intervention, but also context-specific institutional configurations and policy path dependencies. Thus, in considering the influence of a particular policy, the choice of instruments and their associated ideas or theoretical rationales may be less important than other factors such as specific design features (for example, duration, level of support, target group), modes of implementation, policy styles and actor constellations, and how these work together in a ‘mix’ over time (Flanagan et al., 2011; Magro and Wilson, 2013). All of this implies that the design, implementation and evaluation of public policies are all far more challenging than much of the literature implies (Morgan, 2013).

And while we use innovation policy as convenient shorthand to refer to policy interventions influencing innovation, strictly speaking, the idea of ‘innovation policy’ makes little sense. Firstly, ‘policy’ refers to multiple, interacting and often conflicting policies operating at multiple levels and in multiple domains and involving many actors, not all of them state actors. Secondly, innovation is not a goal in itself, but rather a potential means to the achievement of many different goals of public policy (and of course innovation processes also create multiple problems that public policies may be expected to address) (Flanagan and Uyarra, 2016).

Martin (2016) uses an analogy between the use of a mix of instruments in innovation policy and the combination of prescription drugs. He notes that drugs, particularly if a range of them are prescribed for a variety of medical problems, interact with one another and with the underlying medical problem in a highly complex matter. As a result, the overall ‘drug mix’ may be far from optimum, with a drug for one medical problem potentially counteracting the effect of a drug aimed at treating another. Such interactions may also accumulate over time as new drugs are introduced into the treatment regime.

To Martin’s analogy we would add that the same drug will elicit different responses from different individual patients depending on their physiology, diet, lifestyle and other
environmental factors. Decisions about the efficacy of drugs are made on the basis of averaging across the range of different responses exhibited during trials. And a pharmaceutical compound is a highly standardized intervention – each dose is (or should be) chemically identical. This is certainly not true of most policy instruments, which are inherently social technologies with a high degree of interpretive flexibility, not least in implementation.

18.6 POLICY PATH DEPENDENCY AND INSTITUTIONAL CHANGE

Boschma and Gianelle (2014, p. 10) note how the industrial history of regions ‘shapes opportunities but also sets limits to what can be achieved by regional smart specialization policy’. But it is not just the industrial history but also the policy history of a region that shapes what can be achieved, and one will make little sense without the context of the other. Public policies are adopted not on a tabula rasa but in a context of pre-existing policy mixes and institutional frameworks that have been shaped through successive policy changes (Uyarra, 2010). Past policy decisions clearly constrain the range of options available for current decision makers (Kay, 2006) and there is a tendency for certain kinds of policy instruments and the organizations they create to become institutionalized over time (Flanagan et al., 2011). Valdaliso et al. (2014) reflect on the implementation of smart specialization strategies in the Basque Country in Spain and how their development necessarily involves building from a series of existing policies and organizations. These include the landscape of support actors and structures built over several decades for the promotion of regional competitiveness, which exhibit considerable inertia resulting from past successes, and now pose important challenges for the region (see also Morgan, 2013).

Certainly it is not just economic institutions but also political ones that are subject to increasing returns and path dependency (Pierson, 2000). Legacies of the past thus limit the range of options and constrain the degrees of freedom for action. However, policy path dependence does not preclude change. Going beyond the idea of policy continuity versus disruptive change, Streeck and Thelen (2005) identify three incremental yet transformative institutional change mechanisms: displacement, layering and conversion. According to this view, institutions are not rigid constraints only disrupted by episodic shocks; they evolve and are shaped by how actors (not just rule makers but also rule takers) use them, which allows room for agency and change. As Streeck and Thelen (2005, p. 12) note, theories of institutional change may at the same time be theories of policy change, for policies can have the characteristics of institutions in as much as they are rules for actors that ‘can and need to be implemented and that are legitimate in that they will if necessary be enforced’.

This view of institutional change draws attention to the difference between institutions and behaviour in terms of authority, obligation and enforcement and therefore allows for greater degree of ‘play’ in terms of the rules that actors are expected to follow, opening up opportunities for strategic action by actors that can be a source of change. As Lawson (2003) notes, there is an ontological difference between institutions and the practices they govern, shape or constrain. Not all rules will be followed in all cases. There may be differences in interpretation, which can lead to diverse implementations, unintended effects
of actions and learning processes, as well as deliberate strategies to change, circumvent or deviate from existing rules (Streeck and Thelen, 2005). A multiplicity of actors, actor types and governance levels therefore contribute to shaping policy. Viewed in this way, the agency of actors in path creation must therefore be acknowledged not just in relation to innovation processes but also to processes shaping policy problems and solutions. This includes consideration of the multiple roles that actors can play in policy change, for example, as beneficiaries, implementation agents or policy entrepreneurs (Flanagan et al., 2011).

Garud and Karnøe (2001) portray agency as distributed across a multiplicity of actors with different interpretive frameworks being involved in different ways at different stages and embedded in networks and emerging technological pathways. Making and implementing policy is rarely the preserve of a single actor or group of actors: instead it is distributed across a multiplicity of actors across different levels, all engaged in a collective process of negotiation and compromise. Policy agency is also embedded – it is part of the system it is trying to influence, rather than the work of a single, overseeing policy maker somehow operating outside the system (Flanagan et al., 2011). Garud and Karnøe (2003) contrast the strategy of adaptation and gradual transformation adopted by early pioneers of wind turbines in Denmark, which they label ‘bricolage’, with the failed ‘breakthrough’ strategy adopted by National Aeronautics and Space Administration (NASA)-led US wind power researchers, who attempted to generate new technologies by radical innovation. Much policy development resembles this strategy of bricolage – or as Lindblom (1959) put it, ‘muddling through’. For instance, Ebbekink and Lagendijk (2013) argue that cluster policy tends to be a strategy of ‘muddling through’, namely, a succession of incremental changes based on trial-and-error in circumstances of very incomplete understanding. Thus, policy processes and entrepreneurial processes of discovery and innovation have similar evolutionary dynamics. Priorities, rationales and instruments change over time and all actors learn over time – not just adaptive policy makers but also implementers, targets and beneficiaries.

18.7 CONCLUSIONS: PUTTING POLICY INTO EVOLUTIONARY ECONOMIC GEOGRAPHY

The aim of this chapter has been to provide a review and assessment of recent discussions on territorial innovation processes from the perspective of policy design and implementation. We describe how ideas of regional innovation systems have over time incorporated more dynamic accounts of path dependence and path creation. Indeed, in recent years they have come to be seen as complex adaptive systems, with researchers employing a whole set of new terms to understand regional processes of emergence, variety, relatedness, path dependence and co-evolution.

RIS inspired policies have undergone a parallel evolution, from earlier manifesta-
tions of regional innovation policies and strategies that were de facto national policies writ small, through strategies directed at promoting bottom-up experimentation, to the more recent emphasis on smart specialization and on inter- as well as intra-regional connectedness.

We argue, however, that the role of agency in policy processes and institutional change
is still underplayed in processes of path creation and path development. There is a need for a middle ground between narrow firm-led regional branching approaches and a heroic view of policy actors endowed with all the necessary oversight and competences to address any gaps in the system.

Garud et al. (2010) suggest that a focus on agency requires a ‘narrative approach’ able to follow the actors and study processes in real time, an approach that avoids thinking of any sequence of events as inevitable – that is, avoiding ‘retrospective distortion’. Similarly, Flanagan et al. (2011; Flanagan and Uyarra 2016) have called for rich policy histories akin to the rich empirical case studies of innovations from which empirical innovation studies emerged.

Compelling narratives abound of regional transformations and transitions, depicting knowledge relationships and contextual setting surrounding an innovation over time and space, but such narratives are incomplete without considering the agency of actors within the system with respect to policy and the role of policy dynamics over time in path creation, path dependence, lock-in and de-locking. This requires consideration of places as selection environments embedded in national and global contexts that can be purposively shaped by economic and political activities and mechanisms of a wide range of actors. Policy is, in a sense, the outcome of distributed discovery processes just as innovation is the outcome of a process of entrepreneurial discovery, with similar dynamics. Better understanding these dynamics, and in particular the roles played by systemic actors as policy entrepreneurs, implementers, targets and beneficiaries of policy action, and the role of political motivations as well as economic ones, should be high on the research agenda of evolutionary economic geographers and regional innovation scholars.

NOTE

1. A good example of the use of the regional innovation systems literature in policy is the European Commission funded Regional Innovation Strategies (RIS) initiative, which since the 1990s and during the 2000s aimed to build innovation capacity in less favoured regions by improving the institutional conditions and strategic policy capacity in participant regions (Oughton et al., 2002).

REFERENCES


Revisiting the role of policy in regional innovation systems


19. Evolution of regional innovation systems in China: insights from emerging indigenous innovation in Shenzhen

Chun Yang

19.1 INTRODUCTION

Since the 1990s, the geography of innovation has become an important field in economic geography (Shearmur, 2012). One of the most important streams of research is the regional innovation systems (RIS) approach (Cooke et al., 2011). This approach found inspiration in national innovation systems studies, which emerged in the 1980s and early 1990s (Lundvall, 1992; Nelson, 1993; Freeman, 1995). Over the past two decades, the RIS approach has evolved into a widely used analytical framework that has generated solid empirical foundations for innovation policy making, with geographical extension from Western European countries to the Asian economies (Uyarra and Flanagan, 2010; Lee, 2011). This approach has been widely adopted to examine and compare different trajectories of technological upgrading in distinctive institutional environments (Sotarauta and Pulkkinen, 2011), especially in the Asian Newly Industrialized Economies (NIEs). An extensive literature has revealed the diversity of roles played by the state in the emergence and evolution of innovation systems in Singapore, South Korea and Taiwan, respectively (Wong, 1999; Lee and Lim, 2001). In light of these observations, recent work has begun to explore the role that the state and government policies have played in the evolution of RIS in China (Yang, 2014a).

In less developed countries (LDCs) technological spillovers through foreign direct investment (FDI) have often been considered a major engine of technological upgrading. Governments in LDCs, such as China, expected that advantageous technological knowledge embedded in FDI could drive technological upgrading of the local economy. However, since 2000, an increasing number of developing countries have started to question the effectiveness of the FDI-driven technological upgrading strategy, particularly in the aftermath of the 2008 global financial crisis. The mid 2000s witnessed institutional changes and a paradigm shift in Chinese innovation, with an increased focus on indigenous innovation (initiated by the central government in 2006), and state-designated strategic emerging industries (SEIs) as one of the post-crisis resilience policies (introduced in 2009). Recent studies suggest that indigenous innovation policy has engendered the transformation of national innovation systems (Liu and Cheng, 2011). However, relatively little is known about the role of new state strategies, particularly the SEIs, in technological upgrading for regional/sub-national innovation systems (Yang, 2014b).

The state-led transformation of China’s national and RIS has gained momentum in the post-crisis world economy. Since 2000, the global economy has entered a new phase of organization of production and consumption, which has dramatic implications for industrial upgrading (Gereffi, 2014). In the wake of the 2008 global economic crisis, the...
Evolution of regional innovation systems in China

The rapid growth of productivity in China, India and other emerging economies created a profound shift in global demand for both finished goods and intermediates from the Global North to the Global South. As a consequence, these emerging economies became more inward looking and redirected production to their domestic markets and regional neighbours. In some industries there has been a shift in power from lead firms to the large suppliers in developing economies, in which the role of states is clearly growing (Gereffi, 2014). In this fluid context of shifting global production and markets, the effects on innovation dynamics in emerging economies, such as China, are far from clear and have not yet been investigated.

Drawing upon the RIS approach, and bearing in mind these global shifts, this chapter examines the evolution of RIS in China, with special emphasis on emerging indigenous (as opposed to FDI-inspired) innovation in Shenzhen, China’s first Special Economic Zone (SEZ) located in the Pearl River Delta (PRD). The chapter examines the new innovation policies, particularly the development of state-designated SEIs, and their effect on technological dynamics. Particular attention is paid to the emergence of indigenous innovation in connection with the evolution of RIS. The chapter argues that three levels of innovation initiative, together with the way they interact, have impacted on China’s innovation trajectories: these levels are (1) the national government’s innovation strategy; (2) the integration of China’s industries into global value chains/global production networks; and (3) local/regional innovation dynamics, that is, RIS. There has been debate over the sources of innovation, about whether they are external or indigenous, global or local, and about whether technological upgrading is being fostered at the national, regional or local levels in China. The chapter is organized as follows. Following this introductory section, the RIS approach is revisited with emphasis on the changing roles of states in the evolution of RIS. Then, the evolution of RIS in China and Shenzhen is examined through a case study of the TFT-LCD industry. The chapter concludes with a summary of the main findings and a discussion of theoretical and policy implications.

19.2 REVISITING THE RIS APPROACH IN A GLOBALIZING WORLD

It is recognized that innovation is not uniformly distributed across geographical landscapes (Asheim et al., 2011). From the RIS perspective, innovation is a complex set of interactions between public and private actors at a regional level (for example, enterprises, universities, research institutes, agencies, government departments, suppliers and users). A RIS is defined as a system ‘in which firms and other organizations are systematically engaged in interactive learning through an institutional milieu characterized by local embeddedness’ (Cooke et al., 1997, p. 1581). However, the territoriality of innovation systems has undergone dramatic transformation in the heightened globalization. The prevailing innovation systems approaches, which ‘interpret innovation as a systemic process between different actors within and outside a firm, have been questioned for insufficient analytical apparatus to deal with different kinds of relationships with external actors’ (Revilla Diez and Kiese, 2009, p. 248).

During the 2000s various strands in the literature examined the impact of FDI and trans-national corporations (TNCs) in the process of innovation and learning in LDCs,
the most recent attempts adopting the perspective of global value chains (GVCs) (Gereffi et al., 2005) and global production networks (GPNs) (Coe et al., 2004). Unlike the GVC perspective, which places more emphasis on interfirm relations at the international level, the GPN approach argues that successful regional development depends on the ability (or not) of ‘strategic coupling’, that is, the capacity of local actors to couple critical regional assets with extra-local actors involved in global flows. The challenge for policy makers is to establish effective strategic coupling between their regional assets (for example, institutions, capabilities, factor markets and interfirm networks) and the needs and priorities of TNCs. Recent studies, however, argue that being integrated in GVCs or GPNs is a necessary but not a sufficient condition for capturing value (OECD, 2011). As stated by Coe and Hess (2011), ‘the more a region is articulated into GPNs, the more likely it is to be able to reap the benefits of economic scale and scope in these networks, but the less likely it is able to control its own fate’ (p. 134). One of the risks in such relationships is the ‘possibility of institutional capture by external firms at the expense of indigenous firms’ (p. 134). Another risk that arises from the deep integration of regional development with GPNs is the possibility of institutional lock-in (Grabher, 1993), whereby regional institutions are unable to respond quickly to the rapidly changing demands of GPNs, and as a result become either disconnected from these networks or trapped in a form of strategic coupling that does not best utilize regional assets (Coe and Hess, 2011, p. 135). This relates to the recognition that ‘more empirical work on the evolution of the economic landscape is clearly a priority to demonstrate whether institutions affect firms or not and, if so, at what levels of spatial aggregation’ (Boschma and Frenken, 2009, p. 153).

The 2000s ushered a new era of globalization; as the consumption of advanced industrial economies ceased to expand, developing countries around the world began to look for alternatives to declining or stagnant Northern markets. Large emerging economies such as China turned inward and redirected production to their domestic markets and regional neighbours. Within these emerging economies the role of the state is clearly growing (Gereffi, 2014). In the wake of the 2008–09 global economic crisis, economic diversification, impelled by shifting end markets, is reconfiguring the growth opportunities for GVCs and GPNs in ways that shift their orientation towards the domestic markets of large emerging economies, for example, China. The evolving interaction between GVCs and innovation systems has been found to be non-linear, endogenous and mutually affected (Pietrobelli and Rabellotti, 2011). The existing conceptual framework of GPNs has primarily been built on the Western idea of market-driven production networks, and latecomer regions have developed based on their capabilities of meeting the strategic needs, including the market requirements, of Western advanced economies (Coe et al., 2004; Yeung, 2009). Relatively little attention has been paid to the global shift of markets to emerging economies, to the rising need for local technological upgrading, to state intervention, and to their combined effects on regional innovation dynamisms in contemporary globalization.
19.3 EVOLUTION OF INNOVATION STRATEGIES AND CHANGING GEOGRAPHY OF INNOVATION IN CHINA

Since the implementation of the Opening and Reform initiated in the late 1970s, China has encouraged foreign enterprises to locate research and development (R&D) activities in the country, in the hope of knowledge and technology spillovers. However, this ‘market for technology’ policy failed to promote an effective improvement in local companies’ innovation abilities, although it has considerably improved local production capabilities. China’s technology level stills lags behind its economic force, and the issue is causing widespread concern there. In 2006, the Chinese government launched a national science and technology programme focused on ‘indigenous innovation’, advocated in the Medium to Long-term Plan (MLP) (State Council, 2006), which is designed to transform China from a technology follower into an innovation-empowered nation. To improve technological capabilities, domestic enterprises, especially, are encouraged to take a leading role in the new innovation framework. According to the MLP, ‘indigenous innovation’, defined as ‘enhancing original innovation through co-innovation and re-innovation based on the assimilation of imported technologies’ (p. 2), is a massive plan to turn the Chinese economy into a technology powerhouse by 2020 and a global lead by 2050.

The year 2006 marked the end of the five-year schedule of market opening measures – the price of admission to the World Trade Organization (WTO) – and also witnessed the policy reorientation towards ‘indigenous innovation’. This major policy shift has sought to refocus the economy from low-cost manufacturing based on export processing to one based on higher value-added activity (Grimes and Sun, 2014). China’s determination to reduce reliance on foreign technology and gain greater control over intellectual property explains the push from 2006 onwards towards indigenous innovation. This policy has, however, created certain tensions between, on the one hand, the need to develop Chinese technology and, on the other, the need to ensure that China continues to benefit from its growing integration into global innovation networks by acknowledging the key role the country plays in GPNs and GVCs of lead technology corporations (Yeung, 2009).

The 2008 global financial crisis provided even stronger reasons for the Chinese government to take aggressive action in terms of innovation strategy. In 2009, R&D funding reached a historical high, 1.7 per cent of gross domestic product (GDP), surging from 0.8 per cent in 2001. Since the mid 2000s, the central government has begun to repeatedly and publicly declare its intention to develop a more advanced and technology-driven economy. The ongoing campaign of technological upgrading has been implemented in two main ways. One is to foster technological innovation in export-oriented TNC production networks, which have relocated their production activities to China though with limited local engagement in R&D (Yang, 2012). The other is to develop indigenous innovation through technological upgrading of domestic firms. In the aftermath of the global financial crisis, China has turned heavily to government resources to drive innovation (Liu and Cheng, 2011). Notably, seven innovative industries, the SEIs, have been designated to drive China’s growth in the post-crisis world economy (Table 19.1). The State Council (2010) codified the importance of these industries in a policy document in October 2010, which is entitled ‘The decision on accelerating the development of strategic emerging industries’ (‘Decision’). The Decision not only identified the specific industries the central government would target but also established a quantitative target:
Handbook on the geographies of innovation

SEIs should account for 8 per cent of GDP by 2015 and 15 per cent by 2020. While many of the policy details are still being drafted or are in their early stages of implementation, both foreign and domestic firms have increasingly sought to understand how these policies may affect them and what opportunities may exist in these sectors.

Obviously, China’s policy makers are seeking to develop a more sustainable model based on indigenous innovation and domestic consumption, rather than the export-led growth model based on FDI that has prevailed over the past three decades. With demographic change reducing labour supply, and significant environmental problems associated with its ‘world factory’ model, China is under pressure to shift its comparative advantage to more knowledge-based activities. Some scholars wonder whether market forces, particularly domestic markets in a globalizing world, will allow a transitional economy such as China’s to succeed with its indigenous innovation policy (Liu and Cheng, 2011). Furthermore, the frequently expressed dissatisfaction of Chinese leaders with China’s role as a low-cost manufacturer of low-cost products in markets with low margins partly explains its nationalist agenda in science and technology. But a side effect of the political drive behind technology development policy is the huge challenge involved in building the necessary institutions and culture of innovation. In an evaluation of this new policy, Liu and Cheng (2011) call for a more open innovation policy to help Chinese companies reach the necessary level of innovation to compete internationally, and wonder whether the large domestic market in China, which helps local companies prosper, may also reduce incentives for them to become more innovative. An important aspect of the new indigenous innovation policy involves developing the capacity among Chinese companies to absorb foreign technology and to optimize its exploitation for the local market.

Table 19.1 Strategic emerging industries designated by the central, Guangdong provincial and Shenzhen municipal governments

<table>
<thead>
<tr>
<th>National</th>
<th>Guangdong Province</th>
<th>Shenzhen Municipality</th>
</tr>
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<tbody>
<tr>
<td>1. Energy-saving &amp; environment protection</td>
<td>High-end electronics and information technology (IT)</td>
<td>Biological industry</td>
</tr>
<tr>
<td>2. New-generation information technology</td>
<td>New-energy vehicle</td>
<td>Internet industry</td>
</tr>
<tr>
<td>3. Biotechnology</td>
<td>LED</td>
<td>New energy industry</td>
</tr>
<tr>
<td>4. High-end equipment manufacturing</td>
<td>Biotechnology</td>
<td>Cultural and creative industry</td>
</tr>
<tr>
<td>5. New energy</td>
<td>High-end equipment manufacturing</td>
<td>New material industry</td>
</tr>
<tr>
<td>6. New materials</td>
<td>Energy conservation and environmental protection</td>
<td>New-generation industry</td>
</tr>
<tr>
<td>7. New-energy vehicles</td>
<td>New energy and new materials</td>
<td></td>
</tr>
</tbody>
</table>

Source: Based on Yang (2014a).
19.4 EMERGING INDIGENOUS INNOVATION IN SHENZHEN: EVIDENCE FROM EMERGING STRATEGIC INDUSTRIES

A growing literature has developed to compare the innovation activities of foreign and domestic firms in China and to examine distinct innovation dynamisms in the major mega city-regions, for example, Beijing, Shanghai-Suzhou and Shenzhen-Dongguan (Sun and Du, 2010; Lin et al., 2011; Zhou et al., 2011; Wei et al., 2012). Among these, Shenzhen has been recognized as 'a place for innovation for domestic firms, but not for foreign firms' (Zhou et al., 2011, p.145). Shenzhen has cultivated a number of China's most innovative firms, such as Huawei, ZTE and Tencent (Yeung and Liu, 2008; Fan, 2011). Unlike its two counterparts, Beijing and Shanghai, which house prestigious universities and research institutes and with which it is collectively known as the three predominant high-tech cities (Wu, 2007; Zhou, 2008), Shenzhen's principal RIS are characterized by limited involvement of universities and research institutes (Chen and Kenney, 2007). Different from its neighbouring city Dongguan, characterized by grassroots production networks with limited research activities, Shenzhen is considered to have dirigiste production networks that combine with emerging interactive innovation systems (Fu et al., 2011). Recent studies have paid attention to the policy mutation in Shenzhen's urban management, characterized by a transition from learning from Hong Kong's laissez-faire capitalism to Singapore's authoritarian governance (Zhang, 2012, p. 2853). Notably, as the first national innovation city designated by the State Council, the Shenzhen municipal government in 2011 promulgated the first master plan for building an innovative city.

In the late 1990s, export-oriented processing was particularly encouraged. But since 2000, the factors underlying China’s comparative advantage for FDI have evolved, with a much greater focus and with many more recent investments on the domestic market. State policy towards FDI has also evolved, and more recently China has become much more selective about the type of FDI its seeks to attract, partly in response to the relatively disappointing results of the earlier policy of providing market access in exchange for technology transfer. Rather than being an important source of employment creation, foreign capital was expected to bring advanced technology and experts to China. However, FDI perceived China as a low-cost location for production, but this is changing: there is a decline in the labour force, a rapidly ageing population, very low fertility, rising labour costs. The global downturn in recent years did not affect China as severely as other regions during the early stages, that is, 2008–11, partly because of a huge state stimulus package. After 2011, because of excess production capability generated by the stimulus package, with the continuous appreciation of the Chinese RMB and the recession in export markets, China’s export-led growth model faced considerable challenges. Furthermore, the effectiveness of a technological innovation strategy driven by TNCs has been questioned, despite its significant contribution to rapid industrialization via strategic coupling in the GPNs. There has been a paradigm shift of innovation policy towards indigenous innovation through state-led explicit coupling of designated domestic firms and the lead firms in GPNs. This practice remains understudied, with few exceptions (Yang, 2014b).

Obviously, prior to the onset of the 2008 global financial crisis, the Chinese state had already pushed Chinese enterprises to alter the nature of their relationships/positions in the GPNs, with the explicit goals of technological upgrading and greater independence
from TNCs. While the indigenous innovation strategy was implemented from 2006, it was not fully implemented until 2009 in the wake of the global financial crisis. In practice, indigenous innovation has been recognized as a viable strategy to foster technological upgrading in selected sectors in certain city-regions of China. Shenzhen was designated in 2008 by the State Council as a pilot experiment, to be developed into a national innovative city. In Shenzhen and other cities of the PRD region, the Guangdong provincial government designated the so-called ‘empty the cage for new birds’ strategy to foster industrial upgrading in 2008, through which the low-end TNCs, as the ‘old birds’, would be relocated out of the PRD to other less developed areas of the province or to other inland provinces, while the PRD would replace them with high-tech industries as ‘new birds’ (Yang, 2012). The policy aimed to reduce low-end industries while attracting higher-end manufacturing to the PRD. In 2010, seven SEIs were selected by the central government to be technology-intensive with the potential to achieve technological breakthroughs in a short time: these sectors include energy saving and environmental protection, new information technology, biology, advanced equipment manufacturing, new energy, advanced material and new-energy vehicles (Table 19.1). Guangdong provincial and Shenzhen municipal governments announced their own SEIs, which are similar to the national SEIs, and are regarded as ‘new birds’ with huge growth potential, with the likelihood of significant technological breakthroughs and high demand. Little research has been conducted to examine the actual performance of state-selected SEIs, nor to examine the results of joint efforts by various agents to upgrade their technological trajectories.

The geography of innovation in China is therefore not the result of Western style bottom-up and market-driven RIS development processes but has been reshaped by the top-down attraction of ‘new birds’ to coastal cities and regions, for example, Shenzhen and PRD, and by the relocation of ‘old birds’ to less developed areas in Guangdong and inland provinces.

As the first and most successful SEZ in China, Shenzhen, adjacent to the border with Hong Kong, has developed into one of China’s ‘workshops of the world’, driven by the cross-border production networks of foreign investment, primarily from Hong Kong and Taiwan, since 1980. From the GPN perspective, the export-oriented industrialization in Shenzhen can be conceptualized as a ‘strategic coupling’, through conducive institutions (Yang, 2012) of regional assets – for example, cheap labour and land, geographical proximity – with the strategic needs of GPNs, for example, low costs and time-to-market.

Over the past decades, local governments in the PRD, including Shenzhen, have looked positively upon their integration into GVCs/GPNs through TNCs. Dramatic changes in dynamics came when production costs increased due to labour costs, appreciation of the RMB, inflation and an upsurge in the cost of raw materials. These indicated the end of the era of low-cost production driven by TNCs. The changing regional assets coupled with decreasing demand, tight bank credit, price drops required by customers and delays in payment by customers in the wake of the global financial crisis have exerted unprecedented pressure on Shenzhen’s development. This has led to recognition that a strengthening of indigenous innovation capacity is the key to breaking away from the ‘world factory’ model. In parallel with the SEIs designated by the central government, Guangdong provincial and Shenzhen municipal governments have selected their own SEIs to foster indigenous innovation through the technological upgrading of domestic
firms. Since around 2005, there has been a paradigm shift with regards innovation policies, characterized by recognition of the collective and complementary roles of various levels of government in fostering the technological upgrading of domestic firms.

19.4.1 Case Study: The Thin Film Transistor Liquid Crystal Display (TFT-LCD) Industry

The liquid crystal display industry, as one of the SEIs designated by the central government, the province of Guangdong and by Shenzhen municipal government, is selected as a case study to better understand the state-led technological catch-up of domestic firms in selected SEIs. The TFT-LCD industry is one of the state-selected technological and capital-intensive sectors. In the MLP (2006–20), flat panel display (FPD) technology (which includes TFT-LCD technology) was among the 68 pilot industries to be developed first (State Council, 2006). The TFT-LCD industry is situated upstream of consumer electronics and the IT industry. The technological barriers and the prolonged development periods necessary to devise new panel products mean that the LCD TV panel business is concentrated in the hands of just a few suppliers. The five leading suppliers – Samsung and LG-Philips LCD in Korea, Sharp in Japan and AU Optoelectronics and Chimei in Taiwan – collectively shipped 90 per cent of all TFT-LCD panels for TV use in 2005 (Chang et al., 2007). The LCD panel is a core component of TV screens, representing 40 per cent of the total price of a typical TV. China has emerged as the largest market for TFT-LCD panels and has had to import large numbers of TFT-LCD panels from abroad. At present, domestic producers in China mainly rely on LCD panels from Japan and South Korea. The previous coupling to GPNs, with Chinese producers as low-end assemblers without any technological dynamism (Yang and Liao, 2010), is changing, and the ongoing technological upgrading of domestic firms in the TFT-LCD industry indicates the pivotal role played by the state. It was not until November 2009 that the Shenzhen municipal government launched the single largest industrial project investment in Shenzhen since the city’s establishment, with a total investment of 24.5 billion yuan to build its 8.5-generation TFT-LCD factory: China Star Optoelectronics Technology Co., Ltd (CSOT). In 2010 when CSOT was established, two companies, a domestic large TV set producer, TCL, and Shenchao Technology Innovation Company, a venture capital firm solely owned by the Shenzhen municipal government, each held half its shares. One year later, the global leader in FPD production, Samsung, bought 15 per cent of CSOT’s shares from the Shenzhen municipal government, which made the holdings of the three shareholders: TCL 55 per cent, Shenzhen municipal government 30 per cent and Samsung 15 per cent (Table 19.2). In May 2013, the Shenzhen municipal government sold all its shares to TCL, which made TCL the largest holder of CSOT. After these two equity sales, the Shenzhen municipal government was completely severed from CSOT, with TCL holding 85 per cent of the shares and Samsung 15 per cent (Table 19.2). TCL claimed that the transfer of shares is part of a strategy to deepen its upstream business in the TV industry through cooperation with Samsung, one of the world's largest manufacturers of flat screen TVs and mobile phones. The gradual transfer of shares from Shenchao Technology (de facto the Shenzhen municipal government) to Samsung and then to TCL demonstrates the proactive participation of the municipal government in supporting the development of the local LCD industry. This is an example of an explicit state-led strate-
gic coupling between a domestic firm, TCL, and a lead firm, Samsung, by way of a joint venture, CSOT. Moreover, the fieldwork for this study illustrates that TCL and Samsung have become mutual investors in panel production in China. After Samsung acquired its 15 per cent stake in Shenzhen-based CSOT, TCL invested US$100 million for a 10 per cent stake in Suzhou Samsung Electronics LCD industry, a TFT-LCD panel joint venture established by Samsung Electronics at the Suzhou Industrial Park. As noted by the senior manager of CSOT when interviewed, CSOT has manufactured original-designed TFT-LCD panels for Suzhou Samsung, with this outsourced production estimated to be 15 per cent of its 8.5-generation LCD panel capacity. It is expected that the cooperation between TCL and Samsung will increase the international competitiveness of China’s electronics industry (interview in Shenzhen, March 2013). Unlike the implicit strategic coupling fostered by TNCs in the 1990s (Yang, 2009), this is a state-designated strategic coupling of an indigenous firm, TCL, with a global lead firm, Samsung, by way of a joint venture, CSOT. The technological upgrading of CSOT has been facilitated by support from the central and provincial governments, as well as by the active participation of the Shenzhen municipal government.

CSOT has successfully developed its own high value-added technology (wide viewing angle technology) with independent intellectual property rights. In 2012, two years after its establishment, CSOT developed the world’s largest 110-inch full high definition (HD) 3D LCD screen. At the launching ceremony in Beijing on 9 March 2012, TCL donated two of the screens to the Great Hall of the People for public display, replacing sets bought from Panasonic Corporation, in a sign that China’s biggest flat-panel TV maker is adding to the woes besetting the Japanese industry. This technology has been entitled ‘China Star’ (zhongguozhixing), and has made China the third country to have successfully developed high-end display technology, behind Japan and South Korea. The screen display area measures 3.34 square metres, the largest in the world, and the product is equipped with the company’s self-developed Fine Stereo Performance (FSP) technology application. It is predicted by an industry expert that China will replace Japan and South Korea as world leader in TV display screens, in terms of manufacturing and R&D, in three to five years (interview in Shanghai, April 2013). According to the DisplaySearch report, CSOT’s product shipment volume in September 2012 surpassed that of Sharp to become the fifth highest in the world, achieving 9.5 per cent of global market share. By 2012 CSOT had become the second largest LCD panel supplier in the Chinese market, following BOE (TCL News, 5 November 2012).

Table 19.2 Changing share distribution of China Star Optoelectronics, 2010–13 (%)

<table>
<thead>
<tr>
<th>Year</th>
<th>Shenchao Technology (Shenzhen municipality) Innovation Company*</th>
<th>TCL</th>
<th>Samsung</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>45</td>
<td>55</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>2011</td>
<td>30</td>
<td>55</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td>2013</td>
<td>0</td>
<td>85</td>
<td>15</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: A venture capital firm owned by Shenzhen municipal government.

Source: Based on Yang (2014b).
The success of CSOT has enabled TCL to become the first company in China to produce LCD TV sets all by itself, promoting upstream-downstream cooperation and enhancing related industries. Nevertheless, it is worth noting that the successful absorption of technicians has been attributed to the strong financial subsidies from the Shenzhen municipal government. The Chinese government also implemented a new energy-saving home appliance subsidy programme, with a budget of RMB 26.5 billion, to promote the consumption of five types of home appliance that fulfil these standards: LCD TVs, air-conditioners, refrigerators, washing machines and electric water heaters. In 2011, TCL received 0.6 billion yuan in subsidies from the Shenzhen municipal government, which corresponded to over half of its net profits that year (1 billion yuan). In 2010, the government subsidies had been even higher, reaching 0.7 billion yuan (interview notes, March 2012).

The case of CSOT sheds light on an emerging Chinese path to indigenous innovation. The strategic coupling of domestic firms and GPNs (CSOT resulted from a joint venture between TCL, Samsung and the Shenzhen municipal government, and also benefited from the subsequent technological upgrading of the LCD industry in China) is a state-led path to indigenous innovation that warrants further investigation. However, taking into account the pre-existing industrial system that existed in Shenzhen and the state support available in Shenzhen as China’s first SEZ, it is unclear whether the CSOT experience can be replicated in other cities in China.

19.5 CONCLUSION

Since 2000, particularly in the aftermath of the global financial crisis, there has been a rethinking of the role the state should play in the technological upgrading of latecomer cities and regions in LDCs. Despite cases of rapid industrialization via strategic coupling with GPNs, the effectiveness of a technological upgrading strategy driven by TNCs has been questioned. Instead, there has been a shift in state innovation policy towards indigenous innovation, squarely focused on increasing the innovative capacity of domestic firms. By examining the development of the LCD industry, one of the SEIs in Shenzhen, this chapter sheds light on the roles of various state authorities, ranging from the central to provincial and municipal governments, in fostering technological innovation in domestic firms through explicitly coupling it with global lead firms. The case of Shenzhen illustrates how state authorities – central, provincial and municipal governments – TNCs and domestic firms have adapted their innovation strategies and relationships to leverage the rise of domestic demand boosted by the Chinese government in the wake of the global financial crisis and world economic recession. The state-led technological upgrading of domestic firms in the LCD industry, one of the SEIs in Shenzhen, sheds light on some of the implications of the reinvention of China’s innovation policy, which has turned from relying on the expected spillover from TNCs to technological innovation controlled by domestic firms.

The Shenzhen case illustrates the dynamic interplay between technological upgrading of domestic firms and the changing dynamics of GPNs, which has fundamental implications for latecomer regions in the quest for technological catch-up in the context of contemporary globalization. This case also highlights the very different context within which
the location of innovation, and of innovative industries, needs to be understood in China relative to the West. The idea, implicit in the RIS concept, that innovation is a bottom-up market-led process, shaped by institutions, by culture and by light-handed government intervention, bears little resemblance to the way in which RIS are conceptualized under China’s innovation policy. RIS are state-led and are designated by the national, provincial and municipal levels. The case of Shenzhen demonstrates that such an approach can work – at least in some circumstances.

ACKNOWLEDGEMENT

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20. Entrepreneurial regions in theory and policy practice

Helen Lawton Smith

20.1 INTRODUCTION

The entrepreneurship and economic development agenda is one that is both academic and political. Places grow because they generate new firms; new industries emerge and grow, and clusters evolve (Trippl and Tödtling, 2008; Mohr and Garnsey, 2010; Fritsch, 2014). Underpinning the idea of entrepreneurship-led growth is the supposition that entrepreneurship can be stimulated at the regional level by policy intervention.

A dilemma for policy makers, however, is the persistence of entrepreneurial regions independently of politics (Fritsch and Storey, 2014). Fritsch and Wyrwich (2014) find that regions with high levels of entrepreneurship and start-up activity can be expected to experience high levels in the future. They argue that the persistence of new business formation demonstrates the existence of regional entrepreneurship culture that tends to have long-lasting effects.

To address this problem, the European Union (EU) has introduced the European Entrepreneurial Region (EER) project. The EER ‘is a project that identifies and rewards EU regions which show an outstanding and innovative entrepreneurial policy strategy, irrespective of their size, wealth and competences. The regions with the most credible, forward-thinking and promising vision plans are granted the label “European Entrepreneurial Region” (EER) for a specific year.’ Actions to achieve these visions include entrepreneurship education, closer university-industry links, skills development and support for growing firms. The award of EER status is a device for signalling intent inside and outside the region. Indeed, Westlund et al. (2014) observe that areas reporting more positive public attitudes towards entrepreneurship have a higher new business formation rate.

Recent EER winners Lisbon and Valencia in Spain show very different ‘regional’ characteristics and ways in which they position their ambitions. Lisbon, the Atlantic business hub and Atlantic start-up city, exploits its geographic location as a gateway to the Americas, Africa and the EU. It includes attention to the region’s natural resources; the partnership with EER 2013 region Nord Pas de Calais to exchange best practices on social entrepreneurship; the Food Network initiative, which brings together commercial and public sector funders with renowned culinary restaurateurs to create work opportunities for socially excluded citizens; and the Aspire Programme, developed and run by local authorities, which addresses graduate unemployment. The Valencian region focuses on increasing the innovation potential of small enterprises. It assists them through the region’s four Business Innovation Centres (BICs) in coordination with the region’s universities, scientific parks and technological institutes.

However, in the face of more firms, more jobs, wealth creation and lowering
Entrepreneurial regions in theory and policy practice  

unemployment there is still a lack of clear evidence of impact of enterprise policies (Fritsch and Storey, 2014; see also Roper and Hart, 2013). This is in spite of the availability of long-run historical data making it easier to assess factors that underpin the performance of entrepreneurial regions (Fritsch and Wyrwich, 2014).

This chapter is less interested in performance than in process and in understanding how regions become entrepreneurial and which organizations are dominant in shaping visions and coordinating entrepreneurial activity. The high-tech entrepreneurial regions of Oxfordshire and Cambridgeshire in the UK, long-standing rivals in publicity stakes, are used to illustrate how, even in apparently similar regions, there are distinct differences in how the entrepreneurial region concept is developed and enacted at the local level.

Based on evidence from a series of studies of the two regions, most recently one commissioned in 2013 by Oxford University and a local charitable trust (Science Oxford), four sets of data are used to depict the characteristics of each entrepreneurial region. These are the knowledge base, skills and labour market, conditions for start-ups and growth, for example, infrastructure, and entrepreneurial vision. The main argument is that ‘buy-in’ to the entrepreneurial regions concept at the local level is related to the current starting point in the economy – entrepreneurs and entrepreneurial resources including the balance of sectors, size distributions of firms (entrepreneurs) and the mix of organizations (large firms, universities, government agencies). These present sources of potential leaders through whom the political ambitions of the local government might be achieved by engagement in the formulation of a vision that is then put into practice through coordinated entrepreneurial activity.

In the cases of Oxfordshire and Cambridgeshire, entrepreneurial resources are very similar (clusters of high-tech firms, premier universities, highly skilled labour forces, attractive cultural environments and so on). Indeed, Oxford University/Science Oxford (2013) in the report *The Oxfordshire Innovation Engine* shows that there is little to choose between them in the overall performance of their high-tech economies. It is, however, their growth trajectories and how their respective visions have developed and been put into practice that make them different from one another. In 2014, Oxford City leaders were reported in the local paper as asking why Cambridge is ‘streets ahead’.

As shown here, where they differ is in the scale of inter-local authority cooperation, and the sources and activities of leadership. Indeed, the *Oxfordshire Innovation Engine* report identifies the perception ‘that Oxfordshire has lacked the strong leadership and consistent messaging that have benefitted some competitor locations, not least Cambridge’ (p. 6). The implications of the two case studies show that differences between places result from complex sets of interdependencies.

20.2 THE ENTREPRENEURIAL REGION

The entrepreneurial region concept is illustrated in Figure 20.1. The three core elements are entrepreneurs and entrepreneurial resources (skills, knowledge, physical infrastructure, finance and networks), the emergence of an entrepreneurial vision (system elements) and a willingness of putative stakeholders to put that vision into practice through coordinated activity. Of particular interest here is the agency of universities and the extent to
which they become directly involved in local economic development as regional innovation organizers (RIO) (Etzkowitz and Klosten, 2005).

Concepts explaining how entrepreneurial regions develop over time can be categorized into three kinds. First are those that identify the assets of a region and draw attention to particular components such as entrepreneurs, universities, networks and infrastructure associated with patterns of entrepreneurial outcomes such as clusters. The second includes system and evolutionary theories, including regional innovation systems (RIS), and iterations of these ideas, such as regional triple helix models (Etzkowitz, 2008), which vary by their identification of key agents, entrepreneurial ecosystems and stage models. The third elaborates on system features of the second, spelling out the formalization of the process into coordinated action.

**20.2.1 Entrepreneurship and Entrepreneurial Resources**

Entrepreneurial resources are those assets that underpin the rise in levels of entrepreneurship and innovation: in high-tech economies, the accumulation of knowledge and skills leads to a demand for physical and service infrastructures such as finance and communication networks.

A number of approaches attempt to explain increases in the size of the entrepreneur population regions. Of particular relevance to Oxford and Cambridge (and their counties) is explaining why universities give rise to a local increase in the number of entrepreneurs. The knowledge spillover theory of entrepreneurship (Audretsch and Keilbach, 2005) relates economic performance to higher investments in new knowledge such as in university cities. Entrepreneurs exploit the intellectual property of their local institutions. Rates of entrepreneurial activity are explained as being based on new knowledge and opportunity arising from the research strength of the universities (high or low). Entrepreneurship therefore is an endogenous response by individuals to the perceived opportunities provided by investments in new knowledge.

The authors’ localization hypothesis is that knowledge spillover entrepreneurship will tend to be located close to the source of knowledge, in these case studies the universities.
This leads to the entrepreneurial performance hypothesis: that the performance of knowledge-based start-ups in a region should be superior when they are able to access knowledge spillovers through proximity to knowledge sources. Finally, they propose a growth hypothesis: that for a given level of knowledge investment and severity of the knowledge filter, higher levels of economic growth should result from greater entrepreneurial activity. This is in effect a cluster concept (Porter, 1990, 1998, 2003; Iammarino and McCann, 2006). However, clusters have generally been studied from a static perspective (Ter Wal and Boschma, 2011). Nicotra et al. (2014) suggest that evolution dynamics also should be applied to clusters. The knowledge spillover theory of entrepreneurship is therefore complementary to cluster approaches as it emphasizes cumulative processes.

The ‘innovating region’ concept (Etzkowitz and Klosten, 2005, p. 246) places the university at ‘the root of virtually any high tech region’. Evidence supports the significance of universities in the formation of entrepreneurial regions. Fritsch and Aamoucke (2013) find a strong positive correlation between innovative start-ups and the presence of universities and other public research institutions. Several empirical studies have shown that the most innovative founders have at least some academic background (Stuetzer et al., 2012). Universities also contribute graduates to a highly skilled labour market as well as attracting the highly skilled into their regions (Waters and Lawton Smith, 2012). Other studies have suggested an association between high levels of in-migrant workers and entrepreneurship and innovation, as the case in Silicon Valley (Saxenian, 2006). Moreover, inter-firm mobility, particularly by the highly skilled, is a mechanism for technology transfer and fostering of inter-firm links (Breschi and Lissoni, 2009; Faggian et al., 2009). Hence, universities have indirect as well as direct roles in the development of entrepreneurial regions.

Prior to the emergence of entrepreneurs there are people in a region doing other things who have the skills and the motivation to start a company. Audretsch and Keilbach (2005) consider entrepreneurship to be endogenous and taking place within a broader context. Variations in rates of entrepreneurship relate not only to differences in individual characteristics but also to differences in the context in which an individual, with an endowment of personal characteristics, propensities and capabilities, finds him or herself. Similarly, Fritsch and Storey (2014, p. 946) consider the impact of regional context in shaping individual decisions and hence on the outcomes of those decisions.

The regional context includes the relative strength of local business ecosystems (value networks, customer demand, large companies). A lack of a local business ecosystem can inhibit local economic growth. While each company (and entrepreneur) has its own knowledge ecosystem, this does not necessarily translate into a local business ecosystem (Clarysse et al., 2014). The importance of long-established or anchor firms was recognized by Agrawal and Cockburn (2003) and Feldman (2003) in what Clarysse et al. (2014) also describe as a business ecosystem, providing stability in a local economy. Other context-specific factors in the propensity to become an entrepreneur include prior experience in working for a small firm or in a professional environment where self-employment is relatively recent (Sorgner and Fritsch, 2013). Competition between entrants and incumbent firms is also a factor in explaining growth (Fritsch, 2014).
20.2.2 Entrepreneurship-led Regional Growth and Vision

Discussion of how systemic elements develop to give rise to entrepreneurial environments appears, for example, in Feldman and Francis’s (2006) three-stage process model. In this model entrepreneurs are agents who drive the formation and shaping of clusters (emergence, self-organization and a mature stage characterized by a well-functioning system). Progression or stages of development also appear in Etzkowitz and Klofsten’s (2005) four-stage model of innovating regions; and in Etzkowitz’s (2008) three-stage regional triple helix spaces model.

In each there are concepts of inception – the beginnings of an entrepreneurial region, followed by a rapid increase in entrepreneurship activity with networks between entrepreneurs and other actors emerging. This growth leads to further demand from firms including finance, skilled people, physical infrastructure, such as incubators and science parks (Goldstein, 2009), and information gathering networks (see Lawton Smith et al., 2012). Finally, in mature development a well-functioning entrepreneurial system is in place. However, in Feldman and Francis’s approach there is not necessarily a collective vision or coherent approach in the growth stage, nor coordinated activity between key stakeholders designed to overcome system failures in mature stages. The implication is that there are key people who identify what is needed and are thus able to influence how this is translated into policy documents produced by public, private and third sectors.

The RIS approach (Cooke, 1992, 1998) is not a stage model but one that focuses on collective action to foster innovation. RIS ‘are usually understood as a set of interacting private and public interests, formal institutions and other organizations that function according to organizational and institutional arrangements and relationships conducive to the generation, use and dissemination of knowledge’ (Doloreux, 2003). It emphasizes the role of proximity, that is, the benefits deriving from localization advantages and spatial concentration, and governance through territorially prevailing sets of rules, conventions and norms through which the process of knowledge creation and dissemination occurs (Kirat and Lung, 1999).

Evolutionary economic geography has encompassed firm-based accounts of path development in regional industrial development in understanding the ability of regions to develop new growth paths over the longer term (regional resilience). For example, Boschma (2007) summarizes Arthur (1989, 1994) and distinguishes (1) the spin-off model, whereby regions grow firm by firm through spin-off dynamics, and (2) the agglomeration model – the more start-ups enter a region, the stronger the growth. Boschma (2015) proposes that history is fundamental to an understanding of how industrial, network and institutional dimensions (for example, quality of government in regions) of resilience come together to enable a region to accommodate shocks and develop new growth paths. Institutions are also highlighted by Isaksen and Trippi (2014) who argue that an institutional perspective can enhance understanding of regional growth trajectories, drawing on a RIS framework.

The entrepreneurial ecosystem approach (see Isenberg, 2010; Feld, 2012), like the RIS and other evolutionary approaches, stresses the interconnection of actors, with a focus on entrepreneurship rather than innovation. The entrepreneurial ecosystem is ‘a set of entrepreneurial actors, entrepreneurial organizations, and entrepreneurial processes’.
All of these, ‘connect, mediate and govern performance within the local entrepreneurial environment’ (Mason and Brown, 2013, p. 5). In these approaches interaction is through cooperation rather than coordination, the role of government is not fixed, and changes over time.

While arguing that start-up communities, such as Boulder in the USA, can be built up in any city, Feld (2012) is dismissive of the role of the state in stimulating entrepreneurial ecosystems. Mason and Brown (2013) point out that some ecosystems are targeted at start-ups, while others such as the Danish FOR A programme targets young high-growth firms. The evidence, however, is mixed, with some programmes found to be effective and others not (see OECD, 2013).

### 20.2.3 Coordinated Activity

Identification of agents of change, leaders and other main actors and the roles they play is central to understanding processes of coordination. Key questions include what power and influence they have, the scales at which entrepreneurial processes happen and where intervention is needed. In other words, how is the concept of RIS being operationalized (Doloreux and Pareto, 2005) or how is an entrepreneurial ecosystem or a triple helix space brought into being? Is there necessarily a system, and if so how many elements of a theoretical system can be missing for it to still work? In any system there will be gaps (finance, human capital, technology, regulatory and so on), as well as absorptive capacity specific to firms (Cohen and Levinthal, 1990). Charles (2012), in addressing RIS and universities, argues that much university research has little to do with regional innovation.

Regional stakeholder theory (Lawton Smith, 2012), a version of stakeholder theory (Freeman, 1984; Freeman and McVea, 2001) applied at the regional (and inter-regional) level, focuses on agency and attributes of power within interdependent and co-existing networks. A key feature is design, which relates to the ability of lead actors or convenors (Svendsen and Laberge, 2005) to co-opt and influence firm-level activity in a multi-jurisdictional environment with multiple rationalities (Clark et al., 2002). It deals with issues of governance at the regional level as well as multi-level governance of associations and stakeholder interests (Cooke and Leydesdorff, 2006). In the innovating regions model (Etzkowitz and Klosten, 2005) and the regional triple helix model (Etzkowitz, 2008) in mature stages, one or more RIO emerges. This could be either through the creation of a new organization to jump-start knowledge-based regional development or may proceed from the goals articulated in the growth stages, ‘the consensus space’. Governance is coordinated through a group of people or an organization that draws in other key stakeholders. Sometimes universities may be the RIO involved in formulating a knowledge-based regional economic development strategy, such as SUNY Stonybrook in New York State in the USA and Linkoping University in Sweden (Ektzowitz and Klofsten, 2005).

In reality, in top-down policy systems such as France and the UK, the national government sets out the vision behind economic development at the sub-national level. Changes in national policy influence regional behaviour. National governments are also responsible for science policy, which has pronounced spatial outcomes, for example, the continuing dominance of research funding in the UK’s ‘Golden Triangle’ of Oxford, Cambridge and London universities. Iacobucci (2014) makes a similar criticism of assumptions of
bottom-up RIS approaches: in Italy, as in the UK, the design of a smart specialization strategy is necessarily a top-down approach, at least initially.

20.3 OXFORDSHIRE AND CAMBRIDGESHIRE: ENTREPRENEURIAL REGIONS IN PRACTICE

Oxfordshire and Cambridgeshire both have many features of entrepreneurial regions: entrepreneurs and entrepreneurial resources, and some co-existing entrepreneurial visions that have emerged as a consequence of actions, mainly by non-state actors (Svendsen and Laberge, 2005) but sometimes with national/regional/local state support. As elsewhere, they are subject to national policy requirements to implement coordinated entrepreneurial activity.

20.3.1 Entrepreneurs and Entrepreneurial Resources

Cambridgeshire’s profile as a leading cluster of high-tech firms is partly attributable to the publication of the *Cambridge Phenomenon: The Growth of a University Town* (Segal Quince and Partners, 1985). However, contrary to claims made in the report, it was hardly outperforming Oxfordshire. Both Oxford and Cambridge universities are world-leading research universities and, as in Silicon Valley and Boston (Saxenian, 1994), are associated with the rise of entrepreneurial regions.

In 1987 Oxfordshire had 182 high-tech firms employing 10,695 people (Lawton Smith, 1990) compared with the reported 200 employing a similar total number in Cambridge. It was in the 1990s that both became high-tech economies, as more entrepreneurs started their own businesses. Where they differed in the late 1990s was that Oxfordshire had twice the number of firms with over 100 employees than Cambridgeshire, mainly engineering firms (see Garnsey and Lawton Smith, 1998).

Over the decade 1991–2000, particularly between 1996 and 2000, Oxfordshire’s high-tech employment increased by 82 per cent, the fastest growth of any English county. This was mostly in service sectors while manufacturing growth was concentrated in a few high-tech sectors such as cryogenics and instrumentation more generally, and in motorsport. In Cambridgeshire similar developments in the cluster were shaped by early waves of electronics and manufacturing followed by waves of firms in instrumentation, information technology (IT), biology, telecommunications and research and development (R&D) (Mohr and Garnsey, 2010).

By 2011 similar levels of entrepreneurial activity were found, including similar rates of spin-offs from Oxford and Cambridge Universities, but with differences in the extent and composition of clusters, and in the relative proportions of manufacturing and service activity. Both have low numbers of large or anchor firms, but those that exist have been important in the stability of both economies.

Table 20.1 includes a broad definition of high-tech. It is based on Eurostat high-tech sectors and includes medium high-tech manufacturing sectors and selected other knowledge-intensive services in Oxfordshire, the Cambridgeshire sub-region, the Thames Valley and England. These figures include important Oxfordshire sectors, including motor vehicle manufacture, medical instruments and publishing.
Entrepreneurial regions in theory and policy practice

The extent and diversity of clustering is a key difference in the composition of each entrepreneurial region. Oxfordshire is less specialized than the Cambridgeshire sub-region, which has 11 out of the 20 high-tech SIC categories at a Locational Quotient (LQ) of 1.5 or above. In Oxfordshire six high LQ sectors account for 65 per cent of wider-defined high-tech employment; the highest LQs are computers and peripheral equipment (11.4 per cent), irradiation/electromedical equipment (6.7 per cent) (related to the presence of the national laboratories, see below) and scientific R&D (3.9 per cent).

Oxfordshire has a lower percentage of employment in high-tech sectors (6.4 per cent compared with 9.1 per cent), but significantly higher than the national average of 4.8 per cent. Publishing activities are larger in Oxfordshire than in the Cambridge sub-region. In 2011, some 5500 people were employed in this sector, many of them in Oxford University Press, a department of the university dating back to 1586 that is now financially independent from the university.

An indicator of a successful entrepreneurial region is the number and size of its long-established and largest anchor firms (Feldman, 2003). In Cambridge 39 (3 per cent) of the total number of high-tech firms account for 24 per cent of jobs created between 1988 and 2008 (Mohr and Garnsey, 2010). Four local start-ups have achieved considerable growth to employ more than 1000 employees: Domino (ink jet printing), Autonomy (search engines), ARM (chip design) and Cambridge Silicon Radio (semiconductors). At their peak together they employed 6000 and had a combined turnover of £1.4 billion. Although each went through periods of setback in 2002–08, they showed less volatile growth than smaller firms, and provided stability, as did Oxfordshire’s largest high-tech firms, such as Oxford Instruments (scientific, industrial and medical devices), Sophos, a

Table 20.1 Employees in high-tech sectors (wider definition), Oxfordshire, Cambridge, Thames Valley and England, 2011

<table>
<thead>
<tr>
<th>Number of Employees</th>
<th>Oxfordshire</th>
<th>Cambridge</th>
<th>Thames Valley</th>
<th>England</th>
</tr>
</thead>
<tbody>
<tr>
<td>High &amp; Medium High-Tech Manufacturing</td>
<td>13,100</td>
<td>16,500</td>
<td>26,500</td>
<td>716,800</td>
</tr>
<tr>
<td>High-Tech &amp; Selected Other KI Services</td>
<td>29,900</td>
<td>36,400</td>
<td>114,700</td>
<td>1,524,600</td>
</tr>
<tr>
<td><strong>Total: Wider High-Tech Sectors</strong></td>
<td><strong>43,000</strong></td>
<td><strong>52,900</strong></td>
<td><strong>141,200</strong></td>
<td><strong>2,241,400</strong></td>
</tr>
<tr>
<td>Total Employees (All Sectors)</td>
<td>320,600</td>
<td>351,300</td>
<td>783,900</td>
<td>22,929,600</td>
</tr>
<tr>
<td>As % of Total Employees</td>
<td>Oxfordshire</td>
<td>Cambridge</td>
<td>Thames Valley</td>
<td>England</td>
</tr>
<tr>
<td>High &amp; Medium High-Tech Manufacturing</td>
<td>4.1</td>
<td>4.7</td>
<td>3.4</td>
<td>3.1</td>
</tr>
<tr>
<td>High-Tech &amp; Selected Other KI Services</td>
<td>9.3</td>
<td>10.4</td>
<td>14.6</td>
<td>6.6</td>
</tr>
<tr>
<td><strong>Total: Wider High-Tech Sectors</strong></td>
<td><strong>13.4</strong></td>
<td><strong>15.1</strong></td>
<td><strong>18.0</strong></td>
<td><strong>9.8</strong></td>
</tr>
</tbody>
</table>

cyber security firm, and Research Machines, the UK’s leading educational computer supplier (Lawton Smith et al., 2013). However, although they are large in comparison with other high-tech firms, they are not of the same magnitude as ones found in Silicon Valley such as Google, Facebook and Microsoft.

The science base in both regions is extensive. Both have a number of world-leading research laboratories mainly specializing in biomedical science, supported by charities and government-funded research councils, sometimes in association with the universities. However, Oxfordshire has more government-funded research laboratories than Cambridgeshire. Its research laboratories were established firstly to service the UK’s nuclear energy programme (UK Atomic Energy Authority). The composition of this research base has had a growing emphasis on commercial activity through privatization on its ownership and orientation (Lawton Smith et al., 2013).

University spin-offs in both are a source of new firms. Under some conditions they illustrate Audretsch and Keilbach’s (2005) growth hypothesis. A number of Oxfordshire’s and Cambridgeshire’s largest high-tech firms originated in their respective premier universities. In Oxfordshire, spin-offs formed by staff or former students, mainly from departments of engineering science and metallurgy, and more recently from biomedical research, can be dated back to the 1940s and early 1950s. By the mid 1980s, some 40 firms could broadly be defined as spin-offs (see Lawton Smith and Ho, 2006). They include Oxford Instruments (1959) and Sophos (1981). However, while the rate of spin-off has not slowed, there is evidence of weakening recent performance (fewer firms surviving, more becoming inactive). Many, usually biotechnology companies, have been acquired by overseas, usually US, companies.

In Cambridge, Mohr and Garnsey (2010) show that unofficial start-ups by members of the university (staff and graduates) outnumbered official start-ups in which the university held a stake; both types have provided a continuous supply of technology-based firms to the local economy. Moreover, the authors identify further spin-offs from previous ones, providing evidence of the impact of serial entrepreneurship. In Oxfordshire seriality appears to be primarily related to angel investors, recruitment of senior managers and multiple board memberships (Waters and Lawton Smith, 2008).

Over time, both universities have instituted formal technology transfer companies to support the spin-off and other forms of commercialization activity. Isis Innovation (1997), Oxford University’s wholly owned technology transfer company, now employs more than 60 people. It has created over 70 spin-off companies based on academic research generated within and owned by the university, and has spun-off a new company every two months on average. Since 2000, over £266 million in external investment has been raised by Isis spin-off companies, and in 2013 five were listed on London’s AIM market.

In Cambridge, the commercialization process started a few years earlier. In 1983 the Wolfson Industrial Liaison Unit (WILU), established by the Department of Engineering in 1970, became responsible for the commercialization of university research as a whole. During the 1990s, Cambridge University also took steps to simplify the technology transfer system ‘to ensure greater efficiency and professionalism’ (Breznitz, 2011). Breznitz, was, however, critical of its overall effectiveness, finding that the changes to simplify the technology transfer system had had a negative effect on industry’s ability to negotiate with the university.

Associated with the strength of the science base (supply side) and rise of the high-tech
economy (demand side) is the quality of the skill bases in both locations. Both regions have a significantly higher proportion of well-qualified residents than most of the rest of England and Wales. This is particularly the case in Oxfordshire, which has a higher rate of Bachelors-level attainment than any county or Local Enterprise Partnership: 55 per cent of working-age residents in Oxford hold degrees, ranking fifth out of all 380 local authority districts in England, while two other Oxfordshire districts rank in the top 50. In the Cambridgeshire sub-region, 52 per cent hold Bachelor-level qualifications, leading the sub-region to ranking twelfth, but no other district is ranked in the top 50.

This pattern partly reflects the relatively high proportions of Oxbridge graduates, and those of Oxford Brookes, who stay in their respective local areas post-graduation. Both are also destinations for the high skilled from overseas, a feature found to be associated with levels of entrepreneurship (Breschi and Lissoni, 2009). Oxbridge universities are highly international, but more so Oxford than Cambridge (40 per cent and 25 per cent of staff, respectively, are citizens of foreign countries).

20.3.2 Vision and Governance

While documenting formal institutions, both national and sub-national (Fritsch and Wyrwich, 2014) is relatively straightforward, it is much less easy to identify the impact of informal institutions. However, there is some evidence that entrepreneurial visions in both locations emerged in the 1980s and 1990s, with similar local actors in both regions emerging to generate informal interactions. Their existence creates new environments, introduces new actors and agendas and changes local dynamics.

By the mid 1990s, both counties had well-established innovation support networks, whose origins pre-date by nearly two decades policy interest in clusters and ecosystems (Waters and Lawton Smith, 2002). They had distinctively different systems, reflecting the specific geo-historical relationships between local actors, the significant yet differing patterns of state investment in research and decisions made by individual institutions as they responded to changing political environments. The key characteristic in both was that the focal point was not an agency of the state. In Oxfordshire it was the Oxford Trust and in Cambridgeshire the St John’s Innovation Centre.

Both provided specialized premises (and still do), acted as facilitators – including as brokers to provide expert business advice and sectoral support – and have had initiatives designed to raise venture capital for local firms. They forged links with government agencies nationally and regionally, and with local authorities. In both cases the organization’s impact was greater than the size of their budget and specialized remit would suggest: they represented the interests of new high-tech firms to local, regional and national commercial and governmental organizations.

The Oxford Trust (public brand name Science Oxford) is a charitable organization formed in 1985. It was established for the study and application of science and technology, encompassing a broad church of interests including business support, such as helping firms to apply for SMART® awards, activities, managing incubators, networking and a schools programme. The Trust set up the Oxfordshire BiotechNet (a part-governed initiative designed to provide support for the biotechnology industry) and the Oxfordshire Investment Opportunity Network (OION) (which brokers deals between new businesses, business angels and venture capitalists). Early on it established working relationships with
public sector organizations in three other European countries through participation in the European Commission (EC) Fifth Framework KREO project (Karlsruhe, Rhone-Alpes, Emilia Romagna and Oxfordshire), which serves to identify measures to support high-tech SMEs. Subsequently, its local strategic role was downgraded in favour of other local issues (education and infrastructure, such as the Oxford Centre for Innovation). However, the joint sponsorship with Oxford University and the County Council of The Oxfordshire Innovation Engine suggests a current return to centre stage.

The St John’s Innovation Centre, originally an incubation centre, was established in 1987 by St John’s College, Cambridge (see http://stjohns.co.uk/about/, accessed 17 July 2016). While it originally had the specific remit of providing a supportive environment for its early-stage knowledge-based tenants, over time its activities extended to take on functions equivalent to those of the Oxford Trust. It has broadened the scope of its interactions with firms outside the incubator, working in conjunction with the University of Cambridge, the Central and Southern Cambridgeshire Business Link and the Cambridge Enterprise Agency. It has developed ‘as a fully integrated incubator and as a regional high technology SME support agency’.

Networks (formal and informal) are a key entrepreneurial resource. They too have varying origins and positions as convenors. For example, the Cambridge Network, founded in 1998, is a business-led initiative designed to support and promote high-tech industries founded by key players in Cambridge University, as well as by local businessmen and entrepreneurs. In the 1980s and 1990s high-profile individuals in Cambridge such as the head of St John’s College Innovation Centre, the former director of the WILO, were well known inside and outside the university. The Innovation Centre now markets itself as playing ‘a pivotal role in the Greater Cambridge Technology Cluster’. Hence, Cambridgeshire’s networks have remained more formally connected to the university. Those based on the Oxford Trust exclude Oxford University per se, except for academic entrepreneurs and individuals in organizations such as Isis Innovation and the Department of Continuing Professional Development.

Neither Oxbridge university can therefore be seen as a RIO. However, efforts by some of Cambridge’s leading figures and colleges have pulled together key stakeholders to consider the prospects for growth in the Cambridge sub-region. Two main initiatives have been Cambridge Futures (1996) and Horizons (2004). Cambridge Futures, a private sector-led organization, was intended to stimulate thinking about the future development of Cambridge and influence policy decisions. Horizons, a company limited by guarantee, was created to manage delivery of the growth strategy for Cambridgeshire. Its particular contribution to the development of the Structure Plan came through its remit to address issues of congestion and housing shortage, which were identified as constraints on the growth of the high-tech clusters in the second Cambridge Phenomenon report (SQW, 2000). It was a collaboration between key local stakeholders, but was disbanded in 2011 as a result of the withdrawal of government funding (SQW, 2012). Its board comprised a cross-section of partner representatives (elected members) and independent figures from different sectors. This involved all the local authorities, but it did not have statutory planning powers.

Oxford University’s lack of engagement in local economic development has not changed in any major way: its position remains one of not seeing the local hinterland as being of interest (Lawton Smith, 1991). In 1999, however, the university appointed...
Entrepreneurial regions in theory and policy practice

a regional liaison director, who established the Regional Liaison Office. At the time, the appointment ‘underlined the University’s commitment to play a more prominent part in local economic development’. The office was absorbed into Isis Innovation in 2008. As a provider of infrastructure, Oxford opened its own science park, Begbroke, in 2000: the Oxford Science Park (1991) was a college (Magdalen), not a university, initiative. Likewise, the Cambridge Science Park (1970) is owned by a university college (Trinity).

20.3.3 Coordinated Entrepreneurial Activity

In the UK, decisions made at the national level on systems of government profoundly shape the formation of local coordinated entrepreneurial activity that puts visions into practice. Since 2010 and the announced closure of the nine regional development agencies, local authorities have been given a remit by central government to shape their strategies for growth through Local Enterprise Partnerships (LEPs). They have tended to align interests, thus creating a necessary condition for growth – collaboration between key local public and private sector stakeholders, as well as local leadership. Collaboration is intended to bring together the multiple visions of various local actors. Success has been mixed, as there are, for example, significant tensions between Oxford City and the county.

The LEPs in the two regions differ in scale: the Oxfordshire LEP is countywide, but the equivalent in Cambridgeshire is the Greater Cambridge–Greater Peterborough Enterprise Partnership, which covers a much wider area with a population of 1.3 million. Cambridge University is represented on the LEP board by the Cavendish Professor of Physics, also an experienced businessman, at the University of Cambridge, and Anglia Ruskin by the Vice Chancellor. The two universities in the Oxford LEP are both represented at the pro vice-chancellor level.

The national government’s City Deals initiative introduced in 2012 were designed to put visions into practice. They give participating areas the ability to use budgets better for local needs such as training and skills, roads and other developments. In return, the areas must demonstrate they have a strong plan for local growth. The vision, as set out in the Oxford and Oxfordshire City Deal initial award from central government in February 2013, is to ‘accelerate the growth of the city region’s knowledge-based economy’. The vision for Oxfordshire’s entrepreneurial region now bears considerable conceptual resemblance to Audretsch and Keilbach’s knowledge spillover hypothesis combined with the ‘innovating regions’ concept (Etzkowitz and Klofsten, 2005) and a putative RIS system. The aim is to ‘unleash a new wave of innovation-led growth by maximising the area’s world-class assets, such as the universities of Oxford and Oxford Brookes, and “big science” facilities such as those at the Harwell Oxford Campus and Innovation Campus’. The entrepreneurial ecosystem is included by way of the Invest in Growth Hub to help SMEs grow through better business support – with a particular focus on supporting innovation. Transport and housing also form part of the vision.

The Greater Cambridge area was also awarded a City Deal at the same time. Its vision is a wider one, offering ‘a more integrated approach to transport, strategic planning and skills’. While Cambridge won £500 million from the City Deal and is spending it all on transport structure, Oxford received only £50 million and is spending it on a variety of projects.

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City Deals are reinforced by further sources of funding, such as the Regional Growth Fund, a £2.6 billion fund operating across England from 2011 to 2016, which supports projects and programmes that are using private sector investment to create economic growth and sustainable employment. The Growing Places Fund provides a further £500 million to enable the development of local funds to address infrastructure constraints and promote economic growth.

Anecdotal evidence strongly suggests that Cambridge as a city has put significantly more effort into providing new homes, building on the green belt, freeing up roads and investing in public transport, including Cambridge’s guided busway system. There has also been better cooperation between the councils, which cover a very wide geographical area. In Oxfordshire, the area known as Science Vale UK is an exemplar of entrepreneurial vision and coordinated practice.

Science Vale UK includes the Harwell Science and Innovation Campus, one of the UK’s two National Science and Innovation Campuses, home to the Rutherford Appleton Laboratory (RAL), part of the Science and Technology Facilities Council (STFC). It is a public-private partnership and operates as a combined research and innovation park. In 2013 it hosted 150 organizations and companies, employing over 4500 people. It also includes Milton Park, a business park located close to Harwell, and which has more firms, including more university spin-offs, than either of the two university parks (Lawton Smith and Glasson, 2010). In Cambridgeshire a former airfield, Alconbury, located 24 miles west of Cambridge, has been given Enterprise Zone status but has not yet reached the maturity of the one in Oxfordshire.

20.4 CONCLUSIONS

This chapter has used the cases of Oxfordshire and Cambridgeshire in the UK to illustrate some of the complexities associated with the EU’s ‘entrepreneurial regions’ concept. The two cases also illustrate the EER approach – that ‘region’ is a flexible concept, referring to sets of competences brought together to coordinate activity, and that even similar regions can have very different regional resources, characteristics and pathways to ‘entrepreneurial region’ status.

The two counties’ entrepreneurial economies are similar in that they have been led by the growth of mainly small high-tech firms. In each a world-leading university has been influential in the emergence of the cluster. In both cases the universities contribute to the highly skilled labour markets as well as to a branding effect (see Huber, 2012 on the Cambridge IT cluster), rather than having the roles of RIO. The chapter has not attempted to ascribe causality for this growth to public policy intervention. Rather, it has highlighted how entrepreneurs and entrepreneurial resources develop, how entrepreneurial visions emerge and the explicit role played by the state in underpinning coordinated entrepreneurial activity.

However, the two case studies also raise questions about the assumptions underlying the implicit coherence of entrepreneurial activity in both the Audretsch and Keilbach (2005) knowledge theory of entrepreneurship and the innovating region concept (Etzkowitz and Klofsten, 2005) in relation to the role of universities. Evidence from both Oxfordshire and Cambridgeshire shows the expected finding – that universities will be significant
contributors to entrepreneurial resources, for example, with respect to technical linkages for local firms – is absent.

Studies of Oxfordshire have found limited direct contact between Oxfordshire’s high-tech firms and Oxford University, except in the case of spin-offs from the university. This has also been found to be the case in Cambridgeshire. Massey et al. (1992, pp. 38–9) confirm, on the basis of their in-depth interviews in the Cambridge Science Park, ‘other evidence that the overwhelming majority of firms have no research contact with the university [Cambridge]’. Recently Huber (2012) also finds that very few firms in the Cambridge IT cluster collaborate with academics in Cambridge University.

Moreover, the evidence also highlights conceptual problems in interpreting the concept when it is informed by both stage models and system theories. An issue with all stage models, whether they address firms or regions, is that not all regions and firms go through the same process. There are further issues concerning the spatial scales at which processes take place, with different actors operating at multiple scales. Further, it is also not clear that coordinated interactions designed to bring about a particular end – such as entrepreneurship or innovation – actually comprise a system (Charles, 2012).

The Oxfordshire and Cambridgeshire economies now have in place some coordinated actions (LEPs, City Deals, Regional Growth Funds) designed to stimulate further and sustained growth. However, their implicit conceptual underpinnings and their practices are very different. While Oxfordshire’s statements are clearly based on the knowledge spillover theory of entrepreneurship (Audretsch and Keilbach, 2005), RIS and the innovation regions concept (Etzkowitz and Klofsten, 2005), Cambridgeshire’s appear to be more strategic, focused on the business ecosystem approach with greater emphasis on skills and on physical infrastructure – transport and housing. While Oxfordshire might be characterized as having a history of fragmented effort, Cambridgeshire’s recent initiatives in view of economic development can be seen as more integrated, with a more coherent entrepreneurial vision, and have been rewarded by government in consequence.

There may well be historical reasons why neither of these two case studies are complete models of what successful entrepreneurial regions should look like with respect to policy intervention. They are successful for a variety of reasons other than entrepreneurial visions and coordinated entrepreneurial activity. In other locations, however, the right kinds of leadership and leverage of action between local stakeholders are more likely to be able to overcome inertia. Indeed, as Westlund et al. (2014) point out, positive attitudes towards entrepreneurship encourage more people to start firms. Recent EER winners show the diversity of pathways towards success: while Oxfordshire and Cambridgeshire have a head start in a process that is based in part on high skills, ability and environmental quality (Fritsch and Storey, 2014), there are other ways to succeed. It might also be the case that ongoing rivalry between locations that persists over time – for example, between Oxford and Cambridge – may be an engine of entrepreneurial growth.

**NOTES**


4. The Cambridge sub-region comprises Cambridge, East Cambridgeshire, South Cambridgeshire, Huntingdonshire, Forest Heath, North Hertfordshire and Uttlesford and is considerably smaller than that of the Thames Valley (which comprises all ex-Berkshire unitary authorities, plus Basingstoke and Deane, Hart, Rushmoor, Runnymede, Spelthorne, Surrey Heath and South Buckinghamshire).

5. SMART Scheme provided grants to small and medium-sized enterprises (SMEs) for feasibility studies into technology and for development up to pre-production prototype stage of new products and processes involving a significant technological advance (see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/467626/Smart_Evaluation_-_Final_Exec_summary_October_13.pdf (accessed 17 July 2016)).


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Entrepreneurial regions in theory and policy practice 349


Part VI  Transnational mobility and networks: introduction

Richard Shearmur, Christophe Carrinczeaux and David Doloreux

Numerous contributions in this Handbook emphasize the – sometimes overestimated – role of local relations and the extent to which external flows of knowledge and interactions contribute to the innovation process. This penultimate part presents contributions that adopt a logical methodological alternative to focusing on the local, by directly addressing the question of distant interactions.

Of course, different aspects of distant relations have been explored in the innovation field. Empirical work on knowledge spillovers, for example, focuses on the role of distance between agents in order to evaluate the effect of externalities on economic performance. This distance can be geographical, but can also cover other (combined) types of distance in order to weight potential externality channels (for example, input/output matrices or technological distance in patents for Scherer, 1982, and Jaffe, 1986; structure of international trade for international spillover approaches, as in Coe and Helpman, 1995). From a different theoretical background, distant connections are supported by some types of proximity (Ferru and Rallet, Chapter 5, this volume) or by temporary mobility (temporary proximity for Torre, 2008; trade fairs for Maskell et al., 2006). The mobility of firms and global value chains (Beugelsdijk et al., 2010) or the mobility of scientists (Zucker et al., 2002) are also illustrative of this tradition. Questions raised by these approaches are at the heart of the geography of innovation: how does knowledge flow across distance? How does creativity that results from the combination of knowledge occur without permanent geographical proximity? How can one communicate between, and coordinate, actors in distant locations?

The contributions collected in this part shed light on these questions of mobility and distant communication without necessarily converging on any straightforward answer. Three main themes are covered here: the mobility of firms and their networks, the mobility of workers, and the role of information and communication technologies (ICT) and online social networks (OSNs).

The two contributions by Mattes (Chapter 24) and Chaminade et al. (Chapter 22) explore aspects of the mobility of firms in terms of location choices and global innovation networks. They focus on the non-optimality of the decision-making process under uncertainty, and adopt a multi-scalar view of the geography of innovation. These contributions emphasize the difficulty of assessing contemporary trends in the globalization of research and innovation, and therefore add to the 1990s debates on technoglobalism (Archibugi and Michie, 1995) as well as to current debates (Malecki, 2010; Iammarino and McCann, 2013). Chaminade et al. adopt the idea of global innovation networks, arguing that ‘old tools’ (GPN – global production networks – or GVC – global value chains) are no longer appropriate. In contrast, the synthesis of empirical studies on
multinational corporations (MNCs) proposed by Mattes emphasizes the role of these companies and the predominance of home-based strategies. Beyond this divergence, what holds attention here are both the variety of strategies in firms’ location choices and the need to better understand the knowledge creation process to take into account spatial context. The technological emergence of some countries also invites a reappraisal of analytical tools that are based upon developed economy contexts.

The contribution by Breschi et al. in Chapter 23 addresses the mobility of people through migration. By linking the mobility of high skilled (HS) workers with the geography of innovation, they show how the development of original databases can enable this issue to be addressed in a more systematic and quantitative way. Their literature review, by distinguishing the effects of migration on host countries and on countries of origin, focuses on two critical issues for understanding the global geography of innovation. The first relates to the technological emergence of some countries and its impacts on the geography of innovation (as highlighted by Chaminade et al.). The second relates to their original work on the mobility of people within firms, which addresses a little-explored dimension of knowledge flows at the international level, and which combines the mobility of firms with that of individuals.

The contribution by Tranos in Chapter 21 completes these analyses by studying the geography of internet viewed as a remote communication tool. Though debate on the local impact of the supply of network infrastructure remains open (Mack et al., 2011; Tranos, 2013; Erdiaw-Kwasie and Alam, 2016), Tranos highlights the richness of interactions offered by these media, particularly online social networks (OSN). By enabling the development of social capital (shared digital capital), the internet enhances the effects of both local buzz and distant relationships by multiplying weak ties.

All these contributions stress the importance of networks to the geography of innovation and shed light on the role of distant – or non-local – relationships. The geography of innovation involves the simultaneous study of several spatial scales and mobilities, and these chapters offer a glimpse into these dimensions. Whilst there are – in theory – an almost infinite number of possibilities and combinations these chapters are grounded in empirics and observation: which mobilities and which combinations of scales will play key roles in parsing out the geographies of innovation are empirical questions that these chapters broach.

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21. The Internet: its geography, growth and the creation of (digital) social capital

Emmanouil Tranos

21.1 INTRODUCTION

Why should a Handbook on the Geographies of Innovation include a chapter focusing on the geography of the Internet? The short answer to this question is that the Internet can facilitate innovation because of its role as a platform for information and knowledge transfer through its various digital channels. These channels include everything from online social networks (OSN) and the interpersonal interactions taking place within these media, to Massive Open Online Courses (MOOC) and inspiring talks on YouTube. The long answer to this question involves an in-depth understanding of the different layers of the Internet in order to comprehend how the Internet can facilitate innovation and growth. This chapter aims to unpack the latter point.

First, despite common beliefs, the Internet has various spatial structures that result in a number of discrete Internet geographies (Zook, 2006). These different geographies of the Internet, which are usually characterized by spatial unevenness, are, to a certain extent, responsible for the spatially differentiated impacts that the Internet can generate. Therefore, an understanding of these geographies needs to be coupled with an understanding of the economic functions that the Internet has the potential to perform in order to draw a more complete picture of how the Internet may impact connectedness and information diffusion, and by extension the economy, at various scales. Understanding these functions, which relate to the Internet’s General Purpose Technology (GPT) nature, is the focus of the second step of the analysis in this chapter. Most of the current research on this issue has focused on the above two elements – the Internet’s spatial unevenness and its GPT status – while ignoring the latest developments such as the popularity of OSN. Therefore, the following section of this chapter explores how OSN enhance (digital) social capital and therefore contribute to innovation and economic growth. Social capital has been traditionally related, among other economic functions, to the acquisition and transfer of diverse knowledge, which is necessary for innovation production. The chapter ends by summarizing these three sections and proposing future research questions with regards to the spatiality of processes described.

21.2 INTERNET GEOGRAPHIES

The intangible nature of the Internet and its complex technical nature – at least for social scientists – have traditionally justified geographers’ apparent lack of interest in studying the topic (Bakis, 1981; Hepworth, 1989; Kellerman, 1993). Despite not being numerous within the discipline, a number of empirical papers have interrogated the spatiality of
the Internet's various layers. While the purpose here is neither to provide an exhaustive review of these studies nor introduce a new taxonomy of Internet geography studies, this section draws the main lessons learnt from 15 years of research as a first step in the process of better understanding the link between the Internet and innovation.

Despite the different taxonomies introduced (for example, Zook, 2006) and their value for conceptualizing the field, for reasons of simplicity a supply and demand approach is adopted here as a framework to review the relevant literature. Indeed, most research in the field has emphasized the supply side, or, in other words, the geography of Internet infrastructure, of the digital connectivity of cities and the derived digital urban hierarchies. In the late 1990s empirical research in this area tended to adopt a macro scale and focused either on the USA or Europe. The main subject of this stream of research is the highest tier of the Internet's physical infrastructure, Internet backbone networks. A common result is the well-established urban character of Internet infrastructure: because of its private nature, the Internet's physical layer follows demand, which is usually concentrated in large urban areas (Malecki, 2002b; Priemus, 2007). Broadly speaking, one could say that the Internet's physical layer reinforces existing globalization patterns while at the same time leading to the creation of new clusters (Malecki, 2002a). Global cities have always been amongst the most connected cities, but the top of the Internet hierarchy is not monopolized by the handful of well-established global cities. Both in the USA and Europe, new urban hierarchies resulting from the agglomeration of the Internet infrastructure are notably different from more established hierarchies.

Early research in the USA demonstrated that both old and new geographies coexist. The group of most digitally connected cities changed only marginally between 1997 and 2000. New York, Chicago, Washington, DC, San Francisco, Dallas, Atlanta, Los Angeles accrued the most bandwidth in 2000. Four years earlier, the same seven cities were in the top tier, but in a different order and with New York being the fourth city (Grubesic and O’Kelly, 2002; Malecki, 2002a; O’Kelly and Grubesic, 2002). Based on this, Townsend (2001) concludes that for the US case, the dispersal of Internet infrastructure is wider than the world cities hypothesis would have predicted (Tranos, 2013).

Similar spatial patterns, but slightly more scattered, have been revealed for Europe. Previous work illustrated the prevailing role that London, Amsterdam, Paris and Frankfurt perform for the European Internet as well as the gateway attribute that other cities such as Vienna, Prague and Copenhagen perform (Rutherford et al., 2004; Devriendt et al., 2008; Transo, 2011). Explanatory analysis points towards the importance of the knowledge-related attributes of places in attracting Internet infrastructure. Explanatory variables such as patents and Doctorate-granting institutions are better predictors of broadband infrastructure than population. In addition, metropolitan character and market size are also significant predictors of the highest level of Internet infrastructure (Tranos and Gillespie, 2011; Transo, 2013; see also Grubesic and O’Kelly, 2002; Malecki, 2004).

The urban nature of the Internet also emerges when the focus turns from the highest tier of Internet’s hardware to the end-user, broadband connectivity and broadband speed. Although broadband provision is well spread in the USA, data from 2004 reveals a core-periphery landscape (Grubesic, 2008). However, this core-periphery pattern is not as trivial as initial urban-rural or rich-poor spatial dichotomies indicated (Mack and Grubesic, 2009). Aiming to understand the determinants of broadband provision,
Grubesic (2010) identifies population, density, education, income and population age as the main driving forces behind broadband deployment.

Similar heterogeneity is apparent in the UK. Based on user-generated broadband speed data, Riddlesden and Singleton (2014) verify the importance of population density and urbanization patterns in achieving higher broadband speeds. Nevertheless, the high concentration of Internet users in urban areas results in bottlenecks and in lower Internet speeds during peak hours. In a different study, Oughton et al. (2015) conclude that the main factors shaping the distribution of Internet infrastructure in the UK confirm previous findings: namely, dense, wealthy and well-educated areas attract investments in Internet infrastructure.

On the demand side, research has focused on Internet broadband penetration: because of data scarcity most research refers to the national scale only. For instance, Gruber and Koutroumpis (2013) highlighted the positive effect on broadband penetration of competition and lower market power of the incumbent operator. However, competition only has a significant and positive effect when it takes place across the same technological platform: it does not affect broadband penetration when it occurs over different Internet technologies. Using regional data, and after controlling for various socioeconomic factors as well as for unobserved heterogeneity, Dauvin and Grzybowski (2014) confirm the inter-platform competition effect on broadband penetration. In addition, they highlight the important role of competition among different DSL (digital subscriber line) providers on broadband penetration. However, Internet penetration is higher in regions where cable modem has a higher share of Internet access.

Another facet of Internet geography can be revealed by focusing on Internet content. OSN provide a great opportunity for conducting content analysis because they offer access to geo-located data in relation to user-generated content, which is rather easily accessible. Although Internet activity and participation in OSN are not independent from issues of technology diffusion, Internet penetration and Internet infrastructure, research focusing on OSN has the potential to unpack another facet of Internet geography, the geography of its users and their (spatial) relations. Not surprisingly, most of the relevant studies highlight the impact of physical space on the interactions observed within OSN. For instance, although Twitter does not rely on spatial continuity, social ties and interactions based on this popular micro-blogging service are heavily affected by distance decay (Takhteyev et al., 2012; Stephens and Poorthuis, 2014). In addition, factors that have been affecting international trade such as national borders, language and cultural barriers also affect social interactions within this digital medium (Kulshrestha et al., 2012; Takhteyev et al., 2012; Stephens and Poorthuis, 2014). Simply put, social networks based on interactions via OSN such as Twitter mirror existing and well-established social and technical spatial structures including aviation and telecommunication networks (Stephens and Poorthuis, 2014). Given the high spatial and temporal granularity of information derived from OSN, such data is sometimes used to predict human behaviour such as human mobility patterns (Hawelka et al., 2014).

If there is one thing that the various studies of Internet geographies agree upon, it is the spatial heterogeneity of the Internet’s different layers: from the hardware to providers, and from content to users, the Internet’s spatial imprint is uneven and heavily distorted. The Internet is not ubiquitous.
21.3 INTERNET AND LOCAL ECONOMIC GROWTH

Discussion about the economic effects of information and communications technology (ICT) and the Internet has been occurring for the last two decades at least. The classic example is Solow’s productivity paradox, according to which the first evidence of productivity growth due to ICT in the US economy did not appear until the end of the 1990s as the technologies became diffused, adopted and normalized (Cairncross, 2001). Nowadays, the existence of productivity gains caused by ICT penetration is well established, both at the macro (national economies) and the micro (firm) level. The fundamental mechanism behind such productivity gains rests upon the GPT nature of ICT, specifically of the Internet. The latter ‘is a generic technology, which was gradually developed, but once it reached a specific threshold – which in this case corresponded with Internet’s privatization – it was radically expanded across the economy with a huge variety of different applications, creating spillovers which enabled the emergence of the digital economy’ (Tranos, 2013, p. 54; see also Harris, 1998; Malecki, 2002a; Lipsey et al., 2005; Atkinson and McKay, 2007). Such spillovers generate productivity effects in downstream sectors (Helpman, 1998; Malecki, 2002a), which is a mechanism through which ICT and the Internet affect economic growth. From an economic theory standpoint, technology has been an implicit component of growth models, but was traditionally assumed to be constant over time. Only in 1956 did Solow (1956) introduce a model that understood technology as an exogenous (and variable) factor, not dependent on labour and capital (Aghion and Howitt, 1998; Pike et al., 2006). Later, endogenous growth theory (Romer, 1986, 1990) internalized processes of technology and technological change: from this perspective innovation is the outcome of processes endogenous to the economy, and is a key growth factor, leading to increasing returns.

Three broad schools of thought can be identified regarding the economic effects of ICT and the Internet (The What Works Centre for Local Economic Growth, 2015): the Internet enthusiasts who highlight productivity growth related to ICT adoption (Jorgenson et al., 2008; Oliner et al., 2008); the Internet sceptics who question these productivity gains (Keen, 2015); and the middle camp that accepts the existence of productivity effects, but also understands that in order for these effects to take place, specific conditions – usually related to human capital – also need to be present (Brynjolfsson and Hitt, 2000, 2003; Bloom et al., 2007).

Adding another layer of complexity to the above discussion, it is well established that such GPT-related productivity effects can be achieved through investments in physical infrastructure (Lipsey et al., 2005). As discussed in the previous section, the Internet’s physical infrastructure – which consists of its hardware and is the medium for the diffusion of productivity effects – is characterized by substantial spatial inequalities. Therefore, it is necessary to focus on the local and regional scales in order to assess how the unequal distribution of ICT and Internet’s digital infrastructure can generate spatially differentiated economic effects (Tranos, 2012). The results of a number of studies are presented below.

Based on a pan-European study, Tranos (2012) evaluates the causal relation between the highest level of Internet’s infrastructure – Internet backbone networks – and the level of economic development of European city-regions. Internet backbone networks are the core of the Internet’s infrastructure and ensure its function and global reach.
The ‘landing’ of these networks in specific locations creates opportunities for very high Internet connectivity. Using a Granger causality framework, Tranos (2012) identifies the spatially heterogeneous causal effects of the infrastructure. The results indicate that although digital infrastructure can generate economic development effects, this is not an automatic process as other conditions need to be present in order for local economies to benefit from such infrastructure.

Focusing on the US counties, Kolko (2012) identifies a positive relationship between the expansion of broadband provision and local economic growth. These effects are stronger in technology-focused industries. While a positive effect is identified on employment growth, no effect is identified on employment rate. A potential explanation for this might be population increase related to the expansion in broadband provision. Also within the USA, Tranos and Mack (2015) focus on the effect of broadband provision on the presence of knowledge-intensive businesses at the county level. The analysis reveals a bidirectional causal relationship between the change in number of broadband providers and the change in knowledge-intensive business service (KIBS) establishments: in other words, there is evidence both that broadband provision reacts to growth in KIBS (that is, broadband providers react to demand) and that KIBS are attracted to counties with good broadband provision (that is, KIBS react to supply). However, this relationship is characterized by strong spatial heterogeneity, which is related to various regional characteristics including, among others, early Internet adoption and the low saturation level of KIBS.

In a broader study, The What Works Centre for Local Economic Growth (2015) systematically reviews previous research on the effect of broadband on local economic growth and highlights four main findings:

- Increase in broadband provision in an area can affect firm productivity and labour markets (for example, employment, income and wages).
- The above effects are not always positive nor large. Moreover, they may be related to other complementary firm investments (for example, labour force training, sales and supply chain-related adjustments).
- These effects can be industry specific, as more technologically sophisticated firms might be in a better position to take advantage of broadband provision.
- In keeping with the urban/rural bias of various digital geographies, broadband effects appear to be larger in urban areas.

These various analyses capture two distinct attributes of the Internet:

- First, the heterogeneous spatial distribution of the Internet’s various facets, including its hardware, which is responsible for the connectivity of businesses and individuals.
- Second, the Internet’s GPT nature that is responsible for the initiation of spillover productivity effects on downstream sectors.

These two attributes emphasize the Internet’s heterogeneous spatial economic effects. However, the analyses and concepts described in this section tend to focus on the supply side, and the underlying mechanism is the potential productivity improvements brought about by broadband connectivity. The next section proposes a change in agenda, moving
from a supply to a demand focus in order to understand how end-users take advantage of digital connectivity and to move beyond the productivity increase narrative.

21.4 ‘DIGITAL’ SOCIAL CAPITAL

Important as it is, the above conceptualization based on supply and Internet productivity effects ignores the demand side and how users utilize Internet connectivity. For instance, a growing share of interactions between individuals is now facilitated by the plethora of online media. Web 2.0, a term that is more than a decade old, describes the underpinning technological mechanism that facilitates such digital interactions. Its main characteristic is the ability to support two-way communications and, as Gulbrandsen and Just (2011, p. 1100) put it, ‘the one interacts directly with the few, and indirectly with the many’. Technologies such as OSN, which are characterized by network externalities (Mesch et al., 2012), facilitate human interactions within the digital sphere, enabling the formation of new, or the maintenance of existing, social ties. Such digital ties may represent trust, bonding or bridging links (Ellison et al., 2007; Mandarano et al., 2010; Neves, 2013; Isaksen and Karlsen, Chapter 16, this volume), or even flows of information and knowledge (Grabher and Ibert, 2013), which might positively affect innovation (De Dominicis et al., 2013; McCann and Ortega-Aguiles, Chapter 1, this volume). In other words, such digital interactions may represent a ‘digital social capital’ and therefore might have the potential to generate economic effects because they can ‘improve the efficiency of society by facilitating coordinated actions’ (Putnam et al., 1993, p. 167) and act as a complement to other factors of production just like traditional, non-digital, social capital (Fukuyama, 1995). This section explores the digital dimension of social capital and starts with a short description of what social capital is. Then, using existing empirical research, two points are made: (1) social capital positively affects innovation and economic growth; and (2) OSN increase social capital. In order to further unpack the economic role of digital social capital, the local buzz/global pipeline metaphor (Bathelt et al., 2004) is used as a framework for the analysis.

Prior to elaborating the above argument, it is worth framing social capital, a task that is not trivial given its fuzzy nature (Iyer et al., 2005). Numerous definitions of social capital can be found, but it is beyond the scope of this chapter to provide a systemic review.1 Probably the most celebrated definition comes from Putnam et al. (1993) and Putnam (2001), who propose that social capital is based on three pillars: trust, norms and social networks. These three elements can ‘improve the efficiency of society by facilitating co-ordinated actions’ (Putnam et al., 1993, p. 167). Bourdieu and Wacquant (1992, p. 14) define social capital purely on the basis of social relations: ‘the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition’ (see also Steinfield et al., 2008). In economic terms, the stock of social capital can be approached as the sum of social ties an individual obtains over time, which enable access to resources, information or assistance: it results in market and non-market benefits (Glaeser et al., 2002; Pénard and Poussing, 2010; Pénard et al., 2013). Scale is an important dimension of social capital. Although most of the discussion around social capital focuses on individuals, Malecki (2012) suggests that the intermediate or meso
scale (such as firms and regions) is the most appropriate scale to study it as this is where the economic effects of social capital are most direct. In the same vein, Glaeser et al. (2002) propose the notion of aggregate social capital, which is the average of individual social capitals after adjusting for all relevant externalities. In a nutshell, social capital is an enabling factor for productive interaction between actors, primarily in near proximity, but also at a distance (Malecki, 2012).

The positive economic effects of social capital are well established. Broadly speaking, social capital has been recognized as an untraded interdependency (Storper, 1995) that contributes to innovation and economic growth (for example, Whiteley, 2000; Pénard and Poussing, 2010). This is because of the role that trust and social ties perform: while the former acts as a lubricant for collaboration and reduces transaction costs in an uncertain world, the latter reduces the cost and increases the speed of information flow (Putnam et al., 1993; Fukuyama, 1995; Malecki, 2000; Cappellin, 2004; Fountain, 2004; Beugelsdijk and Van Schaik, 2005). As Arrow (1970, p.22) says, '[i]t is useful for individuals to have some trust in each other’s word. In the absence of trust, it would become very costly to arrange for alternative sanctions and guarantees, and many opportunities for mutually beneficial co-operation would have to be foregone.’ With regards knowledge flows, Westlund (2006, p.91) emphasizes social capital’s role: ‘good social relations facilitate knowledge transfers while absence of relations or bad relations do not’. Both these attributes of social capital – that is, the facilitation of trust and of knowledge transfer – have the capacity to enhance innovation processes (Bauernschuster et al., 2014). For instance, Rutten and Boekema (2007) underline the regional role of social capital, presenting it as the instrument that converts technology to economic development by way of regional innovation networks. According to Akçomak and Ter Weel (2009), the explanation for this lies in social capital’s capacity to mitigate the risk involved in innovation activities by establishing trust relations between researchers and entrepreneurs. Malecki (2000, 2012) emphasizes the role of social capital in supporting innovation activity by decreasing the cost of obtaining diverse information. Both attributes of social capital have the capacity to affect innovation and therefore economic growth. This section focuses on how ICT and OSN affect these processes.

A first item to consider is whether ICT increases or decreases the stock of social capital in a society. Putnam (2001, p.171) asked this question before the massive expansion of OSN: ‘[s]ocial capital is about networks, and the Net [that is, the Internet] is the network to end all networks’. Before the term Web 2.0 became popular, Resnick (2001) predicted that social network sites would bring about new forms of social capital and relationships. Going a step further, some researchers have suggested that OSN have a particularly positive effect on the creation and maintenance of weak ties (Wellman et al., 2001; Donath and Boyd, 2004; Steinfeld et al., 2008). More recently, and from an empirical point of view, Bauernschuster et al. (2014) identify a positive impact of broadband Internet connectivity on social capital. In a series of OSN-specific studies, a robust connection between Facebook usage and indicators of social capital is identified, especially bridging ties but also bonding ones (Ellison et al., 2007; Steinfeld et al., 2008). OSN such as Facebook, as well as providing opportunities to enhance and maintain existing (bonding) social ties, also provide opportunities to create ties with friends of friends (Neves, 2013), ties that can be characterized as bridging links. Therefore, it can be said that ICT and OSN increase, and may even create, social capital (Pasek et al., 2009; Mandarano
et al., 2010; Pénard and Poussing, 2010; Neves, 2013). This observation should come as no surprise as it mirrors the effects of previous waves of technology: ‘both the history of the telephone and the early evidence on Internet use strongly suggest that computer-mediated communities will turn out to complement, not replace, face-to-face communities’ (Putnam, 2001, p. 179). Overall, the relevant literature presents empirical evidence that ICT, and more specifically the massive expansion of OSN, result in an increase of the stock of social capital.

In order to unpack the economic role of OSN and human interactions supported by digital media, the nature and the attributes of such interactions need to be understood. Bathelt and Turi (2011) provide a useful comparison between face-to-face (F2F) and ICT-mediated interactions. The starting point of this comparison is media richness, which can be understood as a continuum spanning from F2F interactions to writing correspondence and is related to the presence of non-verbal cues (that is, gestures and body language are fully visible during F2F interaction but absent in letter correspondence). The ability of a communication medium to transfer such non-verbal cues reduces uncertainty and resolves potential ambiguities (Song et al., 2007). While no ICT-supported human communication can reach the media richness of F2F interaction, the latest waves of ICT are characterized by increased ability to communicate non-verbal cues in comparison to earlier ones. Because of uncertainty reduction, media richness is also positively related to social relationship initiation – and ICT has traditionally scored rather low.

The creation of social ties is supported by physical proximity as it decreases the effort an agent needs to expend to initiate communication. This argument lies at the core of economic geography and can be traced back to Tobler (1970). However, one of the integral elements of current OSN is the ability of users to connect with their friends’ friends, an attribute that enables weak ties to be established.

The ability to transfer tacit knowledge is another dimension along which ICT-based and F2F interactions can be compared, and is probably the most widely used in economic geography. Tacit knowledge, which is implicit as well as agent and context specific, is not easily transferable. Indeed, the difficulty of transmission over long distances has been put forward as one of the main reasons for industrial clustering. Although modern teleconference technologies support some tacit knowledge transfer, the superiority of F2F interaction, of the co-location of agents and learning-by-doing cannot be challenged (Bathelt and Turi, 2011; Song et al., 2007). However, given the importance of remote links as a means to access diverse knowledge in innovation processes, and given that co-location is not always possible, human interactions facilitated by OSN may perform a significant economic role.

The remainder of this section will shed some light on whether OSN-supported social ties perform any significant economic role similar to those of traditional – non-digital – social connections. Although ICT cannot replace the media richness of F2F interactions, the latest technological developments have increased the capacity of OSN to support digital interactions that are meaningful in terms of social capital. The ‘local buzz and global pipeline’ metaphor (Bathelt et al., 2004) provides a useful starting point for apprehending the economic role of such digital interactions. While buzz represents the value of F2F interactions, the pipeline element refers to the importance of remote partners in knowledge exchange and innovation production. And while local buzz can be related to knowledge spillovers, the importance of which is well established in agglomeration
Handbook on the geographies of innovation

Economies, digital interactions may represent a different facet of social capital: a type of social capital that is facilitated by digital channels of interaction and information exchange such as OSN. Although the economic geography literature has moved beyond the clear dichotomy of local buzz/global pipelines (Fitjar and Huber, 2015), there is a consensus on the importance of interactions at both scales (Bathelt and Cohendet, 2014).

Local buzz is a notion characterized by strong spatial embeddedness. Local buzz, and the related knowledge and information flows, are facilitated by both organized and spontaneous meetings that can take place without any substantial cost because of the co-location of actors (Bathelt et al., 2004; Storper and Venables, 2004). ICT cannot act as a substitute for F2F interactions and therefore agglomeration economies do not lose their strength even after the vast penetration of ICT (Gaspar and Glaeser, 1998). Thus, there is little room for local buzz to be affected by OSN and ICT. Having said this, OSN can facilitate F2F meetings through mobile Internet access and through ‘check-in’ functions that enable actors to navigate more efficiently within a city. Likewise, the speed of communication related to OSN, including the availability of one-to-many channels, can also increase the speed of information circulation locally and can also support search and matching processes within virtual communities with a spatial footprint (Grabher and Ibert, 2013).

However, the element of the above metaphor most affected by the vast penetration of ICT and OSN is the pipeline. Until recently, personal and informal networks were considered part of the local buzz, while global pipelines were recognized as outcomes of formal linkages (Storper and Venables, 2004; Fitjar and Huber, 2015). However, recent research highlights the importance of informal global ties in building inter-organizational partnerships (Allen, 2000; Saxenian and Hsu, 2001; Hansen, 2014). Such global pipelines are often based on complex social processes, which are grounded in informal personal links (Lorenzen and Mudambi, 2013; Fitjar and Huber, 2015). Although both formal and informal global pipelines facilitate (diverse) knowledge transfer, they are related to firm-level innovation activity in dissimilar ways. As Fitjar and Huber’s (2015) empirical results indicate, informal person-to-person global links are more robustly associated with product innovation than firm-to-firm global partnerships. The importance of global ties lies in the value of knowledge that such links have the potential to carry: because of the distance between the actors involved, such global links tend to facilitate the transfer of diverse knowledge, that is, knowledge that cannot be accessed locally (Cohen and Levinthal, 1990; Hansen, 2014). In other words, such informal global links act as bridging social capital, which is related to the acquisition of diverse knowledge (Malecki, 2012). Of course, the importance of such informal ties is not the same across all industries and is directly associated with an industry’s level of sophistication. The economic role of such informal links between remote actors has just started to be explored (Bathelt and Turi, 2011): the role of ICT and OSN in supporting long distance informal ties has been observed but has not been tested within an empirical framework, and the broader effects that such links might generate in cities remain unexplored. In other words, we still do not have enough knowledge to understand the economic role of digital links between remote actors at a scale larger than that of an industrial cluster.

Although digital technologies have dramatically decreased the cost and increased the media richness of telecommunications, the effect of ICT on global pipelines extends beyond these direct impacts to the maintenance of (and increase of?) informal global ties.
ICT, mostly by way of OSN’s vast penetration, has the capacity to generate some form of virtual buzz (Bathelt and Turi, 2011), a buzz embedded in social networks that transcends specific locations (Rosenfeld, 2011). The increase in social capital that can be attributed to OSN is based on the increase in bridging ties that connect dislocated actors over long distances without cost, whether in terms of personal commitment, time or money. This OSN attribute directly affects the density, durability and ease of activating informal ties. Such ties can remain latent and be initiated ‘just-in-time’ to transfer flows of diverse knowledge that cannot be accessed locally. And as indicated above, such global informal ties, in other words the digital facet of social capital, can support innovation activity and hence economic growth.

An obvious critique of the arguments just outlined relates to the capacity of OSN and digital media to transfer tacit knowledge. As mentioned above, knowledge is supposed to be ‘sticky’ and knowledge transfer has traditionally been related to the co-location of actors, geographical proximity and F2F interactions (Storper and Venables, 2004). However, recent technological developments, including the vast penetration of OSN and the related ease of accessing remote actors – teleconferencing is now available from mobile devices, something that was virtually unthinkable even ten years ago – might challenge the monopoly of geographical proximity as the only medium for tacit knowledge transfer. As Bathelt and Turi (2011) argue, the complex interactions between remote actors now enabled by OSN and teleconferencing applications can build ties even without the co-location of actors, especially when combined with sporadic F2F that build or maintain social connections and trust.

In sum, it has become clear that ICT has introduced a new digital dimension to social capital. Digital technologies and their vast penetration at a global scale have altered the capacity of remote actors to create and maintain social ties. Although ICT cannot fully replace the efficiency of F2F interactions for tacit knowledge transfer, OSN have been instrumental in creating and maintaining weak social ties between distant locations. Moreover, as we know from the global pipeline metaphor, informal social ties that link remote actors might be more important for knowledge exchange and innovation than even F2F interactions, at least in some high value-added sectors: and this is exactly where the potential contribution of OSN lies with respect to innovation. OSN have become the new medium that dominates the creation and preservation of weak ties, and that can infuse local industries and clusters with diverse knowledge embedded in remote locations. Given the positive effect of social capital on innovation and economic growth, and given the Internet’s proven role in enhancing social capital, this chapter proposes that the principal mechanism that enables modern ICT to affect innovation, and hence economic growth, is OSN’s enabling and enhancement of digital social capital.

21.5 CONCLUDING REMARKS

A few lessons can be extracted from the above review. First, spatial heterogeneity is an inherent characteristic of the Internet. Every layer of the Internet (from the hardware to Internet users) is unequally distributed across space. Although this may be surprising to those unfamiliar with the Internet’s complexity, it reflects, but at the same time challenges, existing core-periphery patterns and urban hierarchies (Tranos, 2013). In other
words, although agglomeration forces are still strong and able to explain most of the Internet’s geographical variation, there are opportunities for peripheral areas to perform new roles within the digital economy. Second, the Internet has the potential to affect the economy by virtue of the fact it is a GPT: because of its pervasive nature, the Internet – and digital technologies more generally – affect every sector of the economy, providing opportunities for industry-specific innovation and for productivity increases.

If productivity was the principal pathway through which the Internet generated economic effects in its early stages, this chapter proposes that online social networking will play an increasing role. The vast penetration of OSN, and its related network effects, has positively affected social capital as bridging ties between dislocated actors have been greatly enhanced. Bridging ties are informal social ties that remain latent and are activated when the need for knowledge transfer arises. Traditionally, bridging ties have been connected with innovation as they enable the transfer of diverse knowledge, that is, the transfer of knowledge between possessors of different types of knowledge. This chapter suggests that OSN, which represent one of the latest rounds of ICT development, have the capacity to positively affect innovation by generating digital social capital, thereby loosening the locational constraints that have limited the extent and number of bridging ties.

The geography of these digitally enabled social ties has not been touched upon in this chapter: however, participation in OSN, just like any other layer of the Internet, is uneven across space. Future research should therefore explore how these layers are interwoven in space and how they affect localized actors and economies.

NOTES
1. For such a review see Neves (2013).
2. ‘Everything is related to everything else, but near things are more related than distant things’ (Tobler, 1970, p.236).

REFERENCES
The Internet: its geography, growth and creation of social capital


22. The geography and structure of global innovation networks: global scope and regional embeddedness*

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22.1 INTRODUCTION

The spurt in de-localization of innovation activities to and from emerging economies (UNCTAD, 2005) has triggered a growing interest among scholars of diverse disciplines in understanding the drivers and consequences of the increased globalization of innovation activities; these scholars have used a variety of concepts, from global value chains to global production networks and global innovation networks. The aim of this chapter is to provide an overview of what we know (and what we need to know) about the structure and the geography of these global innovation networks, by looking, in particular, at the geographic concepts that underpin current work on global innovation networks as well as the spatial implications of the increased globalization of innovation activities.

We start this chapter with an overview of the changes in the concepts that are used to explain the increasing globalization of innovation activities – from global value chains to global production and innovation networks, highlighting how geography and space have been tackled in the different frameworks. In the next section we go deeper into the geographical aspects of global innovation networks, discussing why innovation networks may become global as well as the factors that influence the propensity of firms to engage in local or global networks, with particular reference to the role of regions. Finally, we round up with some suggestions for future research.

22.2 GLOBAL INNOVATION NETWORKS AS A NEW PHENOMENON

Innovation has long been an international phenomenon, but arguably it has not been a global one. The empirical evidence at both macro (Castellacci and Archibugi, 2008) and micro levels (Cantwell and Piscitello, 2007; Saliola and Zanfei, 2009) on the internationalization of innovation activities (mainly research and development (R&D)) suggests that: (1) the majority of R&D is conducted close to a company’s headquarters; (2) when R&D is internationalized, inbound and outbound R&D flows take place between technologically and economically advanced high-income countries; and (3) international flows of R&D have been driven almost exclusively by large multinational companies (MNCs) headquartered in high-income countries (Chaminade et al., 2014). As a consequence, the existing literature has been almost exclusively concerned with analysing ‘the success
achieved by an elite class of firms in a small number of lead countries that benefit from being integrated into such privileged chains and networks’ (Parrilli et al., 2013, p. 971).

Economic geography has long argued that the difficulties in globalizing innovation-related activities are strongly related to the intrinsic characteristics of knowledge and the spatiality of knowledge-creating processes (Bathelt et al., 2004). Tacit knowledge tends to be sticky and bound to specific locations. Exchanging knowledge across large geographical distances is challenging, but not impossible. Recent studies in economic geography have contributed greatly to our understanding of the conditions under which innovation and knowledge-creating activities can be organized across space. We know that geographical distance can be compensated for by other forms of proximity – for example, social or organizational proximity (Boschma, 2005; Gertler, 2008); that knowledge bases influence the geography of knowledge networks (Martin, 2012); and also that the region in which a firm is located can determine the geography of its knowledge networks (Plechero and Chaminade, 2013).

In this chapter we point to evidence indicating that a gradual change is taking place in the predominant paradigm of innovation – the paradigm in which innovation is almost exclusively concentrated in developed countries and globalization of innovation is exclusively driven by large MNCs. R&D and other innovation activities are becoming global, and global innovation networks are no longer a phenomenon that is exclusive to large MNCs. We argue that existing concepts like global value chains and global production networks are quite limited in how they explain the emergence and dynamics of innovation networks, particularly when those innovation networks are formed around relational, reciprocal, long-term relationships, which may or may not be with lead firms. Furthermore, we argue that global innovation networks are highly embedded in territories and are pinned down to certain locations, and that, conversely, regional characteristics have a strong influence on the geography of a firm's innovation networks.

A global innovation network has been defined as a globally organized web of collaborative interactions between different organizations (firms and/or non-firm organizations) engaged in knowledge production that is related to and resulting in innovation (Barnard and Chaminade, 2011). Global innovation networks (GINs) have specific characteristics in terms of their geographical spread (global), the nature of the interactions (networks) and the outcomes (innovation).

A key conceptual issue raised by the emergence of GINs is whether they represent a deepening of a long-standing phenomenon already captured by the literature on global value chains and global production networks, or whether they represent a different organizational form. In the latter case, what are the main characteristics of GINs as compared to global production networks or even global value chains? In other words, how can the global innovation network literature contribute to our understanding of the spatial implications of the increased globalization of innovation activities?

First, the term ‘innovation network’ refers to a network formed with the aim of exchanging knowledge relevant for innovation. The works by Ernst (2006), discussing the role of Asia in the electronics industry, and Cooke (2013a, 2013b), analysing the information and communications technology (ICT) industry and Apple’s network, respectively, are cited as examples of this new stream of literature (Parrilli et al., 2013). In contrast with global production networks (GPNs) (Dicken et al., 2001; Ernst and Kim, 2002; Henderson et al., 2002) the focus of GINs is on knowledge exchange and innovation,
not on production. Some authors in the GPN tradition (Ernst, 2002, 2006, 2009) have gradually been incorporating R&D functions and other high value-added activities into their analysis of GPN in specific industries (for example, electronics) across geographical frontiers, thus moving closer to a GIN rather than a GPN (Parrilli et al., 2013). However, the perspective of innovation as an add-on function of GPN assumes that innovation happens in the same structure as the GPN. From our perspective, such an assumption may be flawed for many reasons. First, the motivation for the internationalization of innovation-related activities is different from the motivation for the internationalization of production. Globalization of production is mainly driven by an efficiency-seeking or market-seeking strategy, while globalization of innovation is mainly driven by a knowledge-seeking strategy (Brusoni et al., 2001; Castellani and Zanfei, 2006; Dunning and Lundan, 2009). Second, the structure of the global network for innovation tends to differ from the structure of the global network for production and this is particularly evident for high-tech industries (Audretsch and Feldman, 1996). So GINs may overlap with GPNs in certain industries (for example, in industries where knowledge creation is based on engineering skills and R&D and other innovation-related activities tend to follow production – the automotive industry, for instance) but not in all.

Likewise, in contrast with global value chains (GVCs) – which correspond to vertically integrated types of interaction – the concept of an innovation network opens up the possibility of looking at external collaborations of a horizontal nature (Barnard and Chaminade, 2011). That is, the coordination mechanism that governs GINs is the network, not the market or the hierarchy, and this has important implications. Networks support exchanges of knowledge based on reciprocal, preferential and long-term relations in which all parties are dependent on resources controlled by another, and ‘there are gains to be had by the pooling of resources’ (Powell, 1990, p. 304). While hierarchies are rather stable and difficult to change, networks have a more open and dynamic character, and thus can evolve over time to respond to the needs of firms as well as their capabilities.

The GPN literature and the GIN literature share a concern about the spatial aspects of globally distributed networks and the importance attributed to institutions (Cooke, 2013b), but while the GPN literature is mainly focused on the distribution of production activities globally, and still today has a strong focus on lead firms, the GIN literature is concerned with the spatiality of knowledge creation processes and knowledge networks. The different aims of GINs and GPNs imply that the actors in GINs and GPNs can be different, and the ways in which GINs and GPNs are organized can also differ. Therefore, GINs may have structures and dynamics that differ from GPNs, particularly in certain industries.

Networks are a more flexible form of organization of innovation activities worldwide, and can be especially appealing to firms in developing countries (Barnard and Chaminade, 2011). Using firm-level data collected through a survey in 2010 in five European countries (Denmark, Sweden, Germany, Norway and Estonia), as well as Brazil, China, India and South Africa, Barnard and Chaminade (2011) provide an empirical overview of the different types of engagement of firms in GINs, the role of different actors, such as MNCs, non-MNCs, as well as larger and smaller firms, in GINs, and, importantly, the role of firms located in high- and middle-income countries in such networks. They found evidence that 12.2 per cent of the sampled firms were engaged in one or another form of GIN. In addition, they found that firms located in middle-income
countries (and especially in India) are most likely to participate in GINs that operate beyond the Triad of developed countries (Europe, the USA and Japan). Although many GINs involve MNCs, they also found a significant number of standalone firms involved in GINs. Similarly, although many GINs involve firms with more than 1000 employees, a substantial number of firms involved in GINs are smaller, having between 250 and 999, or even fewer, employees. In summary, the findings of this study indicate that there is a large variety of actors engaging in GINs, and it confirms that firms in middle-income countries are indeed emerging as participants in global innovation. The evidence suggests that GINs are a new emerging phenomenon in terms of actors and the geographical scope of the networks.

By looking at the spatiality of knowledge, economic geography may provide powerful explanations for why these global networks for innovation are formed and how they are bound to special locations, thus complementing the literature on networks.

### 22.3 THE GEOGRAPHY OF GLOBAL INNOVATION NETWORKS

#### 22.3.1 The Role of the Region in the Spatial Configuration of Global Innovation Networks

Scholars in the field of the geography of innovation have always considered it fundamental to understand the mechanisms and dynamics that – at a regional level – may sustain firms' innovation and competitive advantage in a globalized and interconnected world (Cooke, 2001; Mackinnon et al., 2002; Asheim et al., 2003). This is because, despite globalization, the level of innovation activities as well as the competences required (such as skills, knowledge and institutions; Chaminade and De Fuentes, 2013) remain unevenly distributed across regions (Cooke, 1992; Amin and Thrift, 1994; Cooke, 2001; Asheim and Gertler, 2005).

By underlining regional differences, existing research has directed attention towards the relationships between, on the one hand, certain types of regional knowledge-based competences and regional institutions and, on the other hand, the international network that is sourcing innovation from the region (Asheim and Coenen, 2005; Coenen et al., 2006; Moodysson et al., 2008; Blažek et al., 2011; Martin and Moodysson, 2011, 2013; Sotarauta et al., 2011; Tödtling et al., 2011).

In the literature on knowledge bases it has long been argued that the spatial distribution of the network may be conditioned by the specific knowledge base prevailing in a region (Asheim and Coenen, 2005; Coenen et al., 2006; Moodysson et al., 2008; Martin and Moodysson, 2011, 2013; Asheim et al., Chapter 2, this volume). International networks seem to be particularly important for regional activities based on analytical knowledge, which are naturally more prone to codification processes (Bathelt et al., 2004; Owen-Smith and Powell, 2004; Moodysson et al., 2008). Localized networks, where tacit knowledge and face-to-face interaction occur among customers and suppliers, still remain important for regional synthetic and symbolic knowledge-based activities (Martin and Moodysson, 2013). Thus, global networks may emerge to access specific knowledge bases that are highly concentrated in certain regions around the world.
Other studies in this field have also stressed that the ability of a firm to develop GINs can depend on the specific qualities of the regional innovation system (RIS) in which the firm is located (Asheim and Gertler, 2005; Eraydin, 2005), and, in particular, on the organizational and institutional thickness of the RIS (Amin and Thrift, 1994). The study by Tödtling et al. (2011) shows that in a RIS that is strong in terms of institutions and organizations, firms will tend to establish more domestic linkages with innovation sources, while in a RIS that is marginal firms will tend to establish more international linkages, probably to overcome the limitations of the innovation system in which they are embedded (see Isaksen and Karlsen, Chapter 16, this volume). In a similar vein, Chaminade and Plechero (2015) investigate a number of regions, both in Europe and in emerging economies, and show that firms located in regions that are organizationally and institutionally neither too thick nor too thin engage more in global collaboration for innovation. While firms located in marginal regions may lack sufficient capabilities to engage in a GIN, firms located in strong regions may find the knowledge to innovate directly from the regional pool and may not have enough incentive to look for global partners, regardless of whether they are located in a developed or an emerging economy. The results resonate with some recent work by Srholec (2015), who finds that firms located in weaker institutional environments show a higher propensity to internationalize their innovation activities and engage in global networks for research collaboration.

Chaminade and Plechero (2015) and Plechero and Chaminade (2016b) analyse the spatial distribution of the network of collaboration for innovation in the ICT industry, and find that regions with a high degree of specialization, and therefore with very strong competences in the ICT area, tend to rely more on local networks than on global networks for innovation. Plechero and Chaminade (2016b) also show that emerging economies with a RIS in formation have, in general, a higher propensity to develop ‘truly’ global collaboration for innovation (with partners from the north and from the south of the world) than regions in developed countries where the extent of networks of collaboration for innovation remains mainly within the Triad. This may not only be because of the natural propensity for firms located in developing regions to compensate for their weak RIS by looking to establish collaboration with the most dynamic environments in developed economies but it may also result from the fact that some of these regions have recently increased the availability of well-trained human capital (Li and Scullion, 2006; Mitra, 2006; OECD, 2008). A good pool of skilled people in a region in an emerging economy seems to be an incentive for firms from developed countries not only to offshore R&D but also to establish collaborative networks with local partners in those locations (with suppliers, but also with organizations such as universities and research centres) (Chaminade and De Fuentes, 2013). These last findings show that the regions in which firms have a higher propensity to be involved in GINs are the ones where there is good regional absorptive capacity (Cohen and Levinthal, 1990) but where firms cannot find nearby all the resources they need to innovate.

22.3.2 The Impact of the Geography of Networks on Innovation

In the previous subsection we discussed how regional characteristics, such as the predominance of knowledge bases, organizational and institutional thickness, and the degree of
specialization, influence the propensity of firms to engage in GINs. In this subsection we discuss how the structure and geography of innovation networks influence the degree of novelty (which potentially can have an effect on the innovation dynamics of regions in which these more innovative firms are embedded).

One recent object of study in the geography of innovation is indeed the specific relationship of the geography of the network and the capacity of firms to generate innovation (Trippel et al., 2009; Fitjar and Rodriguez-Pose, 2012). By integrating theories from economic geography (Trippel et al., 2009) and international business (Tallman and Phene, 2007), some scholars have investigated whether a mainly local or a mainly global spatial scale for these innovation networks would matter more for innovation (Bathelt et al., 2004; Boschma, 2005; Gertler and Levitte, 2005; Giuliani and Bell, 2005; Moodysson et al., 2008; Belussi et al., 2010). Their main argument is that local knowledge needs to be complemented by global sources of knowledge, and that, in general, international knowledge linkages are positively related to the innovation performance of firms (Gertler and Levitte, 2005; Doloreux and Shearmur, 2012; Fitjar and Rodriguez-Pose, 2012). However, by and large, they do not specify which spatial patterns of network collaboration may lead to the highest level of innovation performance, particularly in terms of degree of novelty (an exception is the recent work by Fitjar and Huber, 2015), or whether there are differences between firms located in different contexts. Furthermore, with a few exceptions (Grillitsch and Trippel, 2014) the existing literature on the geography of knowledge sourcing does not go beyond the distinction between local/regional, domestic/international, where ‘international’ can include neighbouring countries as well as distant ones and countries at very different stages of development.

Moreover, most of the above-mentioned literature uses evidence from firms in developed economies, and it may therefore fall short in explaining the importance of local or global linkages in less developed countries. In developing countries, firms often innovate by acquiring technology that was developed abroad and adapting it to local needs, or by imitating products developed in industrialized economies (Yeung, 2007; Altenburg et al., 2008; Srholec, 2011). Using dedicated survey data from a Chinese and an Indian region, Plechero and Chaminade (2010, 2016a) investigate the impact of the geographical configuration of innovation networks on the degree of novelty of innovation in firms located in Pune and Beijing. They find that, for firms in these two countries, networks of research collaboration with global partners seem to be crucial for achieving the highest degree of novelty in product innovation. Moreover, research collaboration at a global level seems to be particularly important for ‘new to the world’ innovation, confirming the ideas of scholars studying development that in those contexts global interactions are fundamental for catching up (Pietrobelli and Rabelotti, 2007; Lundvall et al., 2009). These results confirm that in this less developed context, research collaboration at a local level does not seem to be enough to help firms upgrade from innovations that are ‘new to the firm’ to innovations that are ‘new to the domestic market’ or ‘new to the world’.

While in developed countries the role of local institutions and organizations that foster innovation remains crucial, in emerging economies and developing countries the local system of innovation, as well as the local absorptive capacity of firms, may still not be able to stimulate high innovation performance (Grimpe and Sofka, 2009). These findings confirm what previous authors had already claimed – that location-specific factors have an impact on the likelihood of engagement in an innovation network and on innovation
performance (Crescenzi et al., 2012; Doloreux and Shearmur, 2012; Fernández-Serrano and Romero, 2012; Herstad and Ebersberger, 2015).

A further step in the analysis is to look specifically at the structure of networks – in terms of the actors – as well as the specific location of partners. In a series of exploratory papers based on the INGINEUS survey, Harirchi and Chaminade (2014) and Aslesen and Harirchi (2015) introduce both the location of the firm and the location of the partner in the network to investigate their impact on degree of novelty. Harirchi and Chaminade (2014) analyse the role of collaboration for innovation with global users (as one specific type of actor), by making a distinction between users located in the south and users located in the north, as well as considering the location of the focal firm. Their findings on a sample of ICT, agro-processing and automotive firms show that firms in emerging economies benefit more from interaction with users in the south, while collaboration with users in the north does not yield any positive impact in terms of a higher degree of novelty for these firms. On the other hand, firms in the north benefit from user-producer collaboration with firms in the north and in the south. When the sample is limited to one specific sector (ICT) and to small and medium-sized firms in Sweden, Norway and India, the results of Aslesen and Harirchi’s (2015) comparative study of ICT firms show that firms in Norway and Sweden benefit more from global linkages in relation to the novelty of innovation than do Indian firms. Their overall results imply that engaging in GINs and benefiting from such linkages is both sector- and country-specific. Furthermore, the degree of engagement in global linkages may also be moderated by both resource support and strong regional innovation systems (Ebersberger and Herstad, 2013). Too much dependence on local interactions for innovation (Visser and Boschma, 2004), at least in the case of smaller countries such as Norway or Sweden, may generate system lock-in that inhibits the generation of radical innovations (Uzzi, 1997).

22.4 IMPLICATIONS FOR A RESEARCH AGENDA ON THE GEOGRAPHY OF INNOVATION NETWORKS

GINs seem to be a relatively new phenomenon and the literature dealing with the structure and dynamics of GINs is still in its infancy, in both theoretical and empirical terms. Theoretically, the GIN literature can be enriched by developing a framework that integrates knowledge base characteristics (transferability and availability of knowledge), firm idiosyncrasies (accessibility of knowledge), location (territoriality) and structural network characteristics. By adopting a multi-level and multi-scalar approach we can understand the micro- and meso-level dynamics that influence the geography of innovation networks and how this changes over time.

Advanced tools in social network analysis (SNA) can be used for an empirical approach to this multi-level and multi-scalar analysis. Hitherto, with very few exceptions (Balland, 2012; Cassi et al., 2012; Balland et al., 2013, 2015), most of the studies on global knowledge and innovation networks have been rather static or confined to only one form of innovation network. Studies on the dynamics of GINs are sorely needed. However, the geographical coverage of these studies is limited by the need to use certain indicators for which there are available relational data (co-patenting, and co-publications as a proxy for research collaboration) or is confined to a number of countries for which
richer relational data is available. Regarding data, a very promising line of research is based on the construction of relational data from social media and other internet-based networks, on a global scale and over time. In terms of geographical coverage, a particular future research area related to south-south and south-north interactions, to complement the dominant north-north perspective, should be explored.

A field of research that also deserves more attention relates to understanding how the dynamics of GINs may or may not favour economic development in certain regions. Further research may be devoted to investigating where the main value of innovation activities is retained, geographically speaking.\(^\text{14}\) While this is a topic that has been extensively analysed in relation to GVCs and GPNs, it still remains in its infancy from the GIN perspective. Related to this, another promising line of research is to investigate how GINs contribute to path creation, defined as the emergence of new industries, and path renewal, the branching of existing industries into different and related ones (Isaksen and Trippl, 2014).

NOTES

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1. A GPN is defined as ‘the globally organized nexus of interconnected functions and operations by firms and non-firm institutions through which goods and services are produced and distributed’ (Coe et al., 2004, p. 471).
2. Notably, engineering, product development and R&D.
3. The global scope measure was based on the question, ‘Regarding the development of the most important innovation of your firm in the last 3 years: who did you actively collaborate with and in which geographical location?’ If firms were relying on at least one innovation partner from a Triad country as well as at least one innovation partner from an emerging location, they were coded as global (g). If firms relied on innovation partners outside their home country from at least two traditional Triad regions, and from at least two middle-income regions, they were coded as highly global (G). The network scope measure also relies on the question, ‘Regarding the development of the most important innovation of your firm in the last 3 years: who did you actively collaborate with and in which geographical location?’ Regardless of the geographical locations in which a partner could be situated, the authors simply identified whether or not a firm had worked with a particular type of partner to innovate. In the measure of network scope, firms were regarded as somewhat networked (n) if they indicated that they worked with at least three types of network partners, or if they indicated that they offshored innovation.
4. Sources of innovation are considered by this literature to include both market and technological knowledge.
5. Analytical knowledge, characterized by scientific knowledge and rational processes, is devoted to the discovery and application of scientific laws, and is usually relevant for sectors such as biotechnology (Asheim et al., 2007).
6. Synthetic knowledge is defined as knowledge that has originated from the application of or through the new combination of existing knowledge and its construction, and is often triggered by the need to solve specific problems or to answer the specific needs of customers or suppliers (for example, in the engineering industry). Symbolic knowledge is principally built on aesthetic and design attributes, and on the symbolic value of the product (Martin and Moodysson, 2013). This last type of knowledge characterizes, for example, regions and clusters oriented towards fashion production.
7. RIS can be defined as the ‘wider setting of organizations and institutions affecting and supporting learning and innovation in a region’ (Asheim, 2009, p. 40).
8. Regions can be considered strong (institutionally and organizationally thick) when they have a solid organizational infrastructure (that is, a high number and diversity of organizations in that particular...
innovation system), high levels of interaction among local actors, a culture of collective representation and shared norms and values that serve to constitute the social identity of the particular locality (Amin and Thrift, 1994; Tödtling and Trippi, 2005; Asheim et al., 2011). Regions are, by contrast, usually considered marginal (institutionally and organizationally thin) when these elements, or parts of these elements, are missing.

9. The most common and widely accepted definition of the degree of novelty, used in various types of innovation surveys including community innovation surveys – see Hong et al. (2012), Laursen and Salter (2006), Smith (2005) – is related to that given in the Oslo Manual. The manual makes a clear distinction in relation to the degree of novelty: new to the firm (the minimum implementation requirement for an innovation) as opposed to new to the market, new to the industry or new to the world, which all require that the innovation is also introduced for the first time in that specific geographical area or field (OECD, 1997).

10. This survey was conducted across nine countries under the auspices of the European Union-funded INGINEUS Project in 2009. Data on firms in Europe was gathered from certain leading economies with an average per capita income above US$45,000 per year, namely, Denmark, Germany, Norway and Sweden. Estonia, a transition economy, was also part of the survey. Data was also collected from four prominent middle-income countries: Brazil, China, India and South Africa. The choice of countries allows a clear comparison of economies that are global leaders and economies that are emerging economies in the global arena, in line with the overall aim of the project. The survey for each country focused on ICT, the automotive industry or agro-processing, whichever sector was of economic importance in that country.

11. This survey has also allowed a clear distinction to be drawn on the geographic location of resources used for innovation. Locations in the north included North America, Japan, Australasia and Western Europe. Locations in the south included South America, Central and Eastern Europe, Africa and the rest of Asia.

12. In a similar vein, they defined firms to be located in the north if they were in Denmark, Germany, Norway or Sweden (high-income countries), and firms to be located in the south if they were in Brazil, China, India, South Africa or Estonia.

13. See Balland (Chapter 6, this volume) for a discussion of the dynamic approach to network analysis.

14. See Shearmur (Chapter 26, this volume) for a discussion of the local economic impacts of innovation.

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23. Migration and innovation: a survey of recent studies

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23.1 INTRODUCTION

Migration and innovation are two phenomena with long histories, dating back to well before the emergence of professional science and engineering (S&E). David's (1993) historical excursus on the birth of modern intellectual property rights (IPRs) reminds us that they originate from the privileges granted by Italian states of the fourteenth to fifteenth centuries to foreign craftsmen, in order to lure them away from their home countries (or rival states) and inject new techniques into local industry. During the same period, Tudor England actively engaged in ‘the negotiation . . . of secret agreements designed to attract skilled foreign artisans into [the Crown's] service. German armourers, Italian shipwrights and glass-makers, French ironworkers were enticed to cross the Channel in this fashion’ (David, 1993, pp.47–8). Hornung (2014) provides econometric evidence in favour of Frederich List’s (1841) classic argument on the productivity impact of Huguenot migration from France to Prussia after the revocation of the Edict of Nantes in 1685. In a similar vein, Moser et al. (2011) show how Jewish professors of chemistry seeking refuge from Nazi Germany were responsible for a significant growth in US patenting activity in chemical technologies, both directly and indirectly (by opening up new research avenues for US inventors).

What makes the study of migration and innovation a hot research topic today is the steady increase in global flows of scientists and engineers observed over the past 20 years, both in absolute terms and as a percentage of total migration flows (Freeman, 2010; Docquier and Rapoport, 2012). These flows are fed by an increasing number of countries, most notably China, India, and Eastern Europe. This raises a number of questions on the role these migrants play in innovation processes in both their destination and origin countries.

The most common questions asked with reference to destination countries, most notably the USA, can be summarized as follows: are foreign scientists and engineers complements or substitutes for local ones? In other words, do they increase their destination country’s innovation potential or do they simply displace the local workforce (Borjas, 2004; Chellaraj et al., 2008; Hunt and Gauthier-Loiselle, 2010)? Are destination countries increasingly dependent on immigrating scientists and engineers (including graduate students) to maintain their present technological leadership? Does such dependence require the implementation of dedicated immigration policies (Chaloff and Lemaitre, 2009)?

As for origin countries, the key research questions concern the extent of their loss of human capital (‘brain drain’) and the nature and effectiveness of potential compensating...
mechanisms, such as knowledge spillovers from destination countries or the contribution to local innovation by returnee scientists and engineers and entrepreneurs (Kerr, 2008a; Agrawal et al., 2011). In this respect, some debate exists on the role of intellectual property, most notably in the aftermath of many origin countries’ subscription to TRIPs, the Trade Related Intellectual Property agreements associated with adhesion to the World Trade Organization (Fink and Maskus, 2005).

While rich in questions, this emerging literature is still poor in answers. One important limitation concerns the empirical side, and the lack of extensive and detailed data for micro-econometric analysis. Another important limitation concerns its almost exclusive focus on one destination country, the USA, and its top providers of foreign talents over recent years, namely, India, China and other East Asian states. US-centrism is not peculiar to this field of studies, but here it bears the additional disadvantage of reducing a multi-polar phenomenon, one in which several countries act both as source and destination of migration flows, to a set of binary relationships between the USA and a limited set of origin countries.

This chapter reviews existing quantitative studies that address, either directly or indirectly, the relationship between migration and innovation. We first consider general studies on the growing phenomenon of highly skilled (tertiary educated) migration, as well as research on mobility of PhD graduates and scientists. We then survey existing evidence on migration’s impact on destination countries, with special emphasis on specific categories of migrants, namely, inventors and international science and technology students. The following section deals with the impact on origin countries: we review both some general evidence and selected region- or country-specific studies. In the penultimate section we review the special case of intra-company international mobility, and we then conclude.

23.2 HIGHLY SKILLED MIGRATION: GENERAL EVIDENCE

Studies on highly skilled (hs) migration belong to a long-standing tradition of research on migration and development (for a survey of economic studies, see Docquier and Rapoport, 2012; for a cross-disciplinary survey, see de Haas, 2010). The most comprehensive evidence on the phenomenon comes from the DIOC database family, which is based upon information for the 2000 census round, supplemented by labour force surveys, with updates for 2005 and 2010 (related data for 1990 can be found in Artuc et al., 2015). Hs migrants (and residents) are identified as those having tertiary education, that is, a diploma earned at college or university.¹

DIOC data show that, at least since the 1990s, hs migration has grown both as a stock and as a share of total migration (from around 13 million units worldwide in 1990 to 26 million units in 2005/06; and from 30 per cent in 1990 to almost 40 per cent in 2005/06). Besides, migration rates for tertiary educated people are higher than for the non-tertiary educated.

Origin countries of hs migrants are the largest ones, especially those with internationally diffused languages, regardless of their development level. Among the top 30 origin countries worldwide in 2010 we find many European states, starting with the UK (with over 1.5 million hs emigrants) and Germany (1.25 million), followed by Poland, Italy,
France, Russia, the Netherlands, Ukraine, Romania, Greece and Serbia. In a few cases, this translates into rather high migration rates (17 per cent in Poland, over 20 per cent in Romania and 11 per cent in the UK) or at least in above-world average ones (9 per cent for Germany, 8 per cent in Italy and 6 per cent in France).

At the same time, European countries have the lowest share of \textit{hs} immigrants as a proportion of total immigrants. This is due to a combination of immigration policies, which usually do not select by skill, and geographical or historical factors. The net result of \textit{hs} emigration and immigration is nonetheless positive for the largest and most developed countries, including the UK, France and Germany. Italy is the main exception, as it suffers a net loss. As for the least developed European countries, they suffer net losses and high brain drain rates, the main exception being Russia. Note that large non-European contributors to \textit{hs} migration, such as India and China, do not suffer any brain drain. This is due to the size of their population and its generally high education level.

Among the most important categories of \textit{hs} migrants we find doctoral degree holders, especially in scientific and technical fields. DIOC data do not include separate figures for them, but some information can be obtained from the survey on the Careers of Doctorate Holders (CDH), conducted jointly by the OECD and the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 2007 and covering 25 OECD countries (plus a seven-country pilot project in 2003; see Auriol, 2007, 2010). Although not explicitly targeted at migration, and even less at innovation, the CDH dataset contains useful complementary information to \textit{hs} migration statistics. First, we learn that ‘the labour market of doctorate holders is . . . more internationalized than that of other tertiary-level graduates’ (Auriol, 2010, p. 19). Immigration rates for doctorate holders are often double those of tertiary educated in general, ranging from 13 per cent in Germany to 42 per cent in Switzerland (Auriol, 2007).

France, Germany and the UK emerge as the most important destination countries along with the USA, but most of the international mobility from Europe takes place within the continent, while the USA is the top destination for doctorate holders migrating from East Asia and India (who make up 57 per cent of foreign doctorate holders, as opposed to only 27 per cent of Europeans).

Another important category of \textit{hs} migrants are academic scientists, who are the object of the GlobSci survey (Franzoni et al., 2012; Scellato et al., 2012). The survey concerns authors of papers published in high quality scientific journals in 2009, who appear to be active in the 16 top countries for number of papers published. Foreign-born authors (defined as those who entered the country of affiliation after the 18th year of age) are more than half of all authors in Switzerland (57 per cent) and around a third in the USA (38 per cent). They are in between a third and a fifth in several European countries. The only top countries with limited foreign presence are Spain (7 per cent), Japan (5 per cent) and Italy (3 per cent). GlobSci also confirms that migration within Europe is mainly intra-continental and driven by proximity and language effects; and that the USA is the main attractor of Chinese and Indian nationals.
In very recent years, various attempts have been made to exploit archival data for retrieving information on the impact of immigrants on their destination country, almost all of them centred on the USA. The USA has been a historical destination for foreign-born scientists and engineers, with universities playing a key role in encouraging the inflow of foreign students and postdocs, the former now making up around 45 per cent of graduate students enrolled in S&E programmes, and around 60 per cent of postdocs (2006 data, as reported by Black and Stephan, 2010). A debate is ongoing in both the US academic and non-academic press on the extent of foreign researchers’ contribution to scientific advancement and innovation, and on what sort of visa policies to implement. Concerns about the possibility of local S&E students and workers being crowded out have been expressed by several migration scholars, such as Borjas (2009). Evidence of this is the dramatic drop of US citizens’ enrolment in S&E university programmes, or their marginalization in some scientific disciplines (Borjas and Doran, 2012). In addition, it has been noticed that more recent cohorts of foreign-born academic researchers in the USA tend to concentrate in more peripheral and less productive universities and departments, which do not offer attractive career prospects to native students (Stephan, 2012, chapters 7–8; Su, 2012). And yet, such evidence could simply prove the existence of a division of labour based on comparative advantages, with US citizens entering professions for which mastering the local language and culture, as well as having more social capital, matters more than having acquired specific scientific or technical skills. Several efforts have been made, therefore, to investigate whether absolute advantages may be at play, such as when migrant scientists and engineers self-select on the basis of superior skills, thus bringing with themselves knowledge assets and skills that would be otherwise unavailable. Overall, the evidence is in favour of this second hypothesis.

Stephan and Levin’s (2001) pioneering study focuses on the presence of foreign-born and foreign-educated people amongst eminent scientists and inventors active in the USA in 1980 and 1990. The authors assemble a sample of about 5000 highly productive or distinguished scientists and engineers, which include members of the National Academy of Science (NAS), the National Academy of Engineering (NAE), the authors of highly cited scientific paper, a selection of academic entrepreneurs in the life sciences and a small number (around 180) of inventors of highly cited USPTO patents (United States Patent and Trademark Office). The share of foreign-born and that of foreign-educated individuals in each of these categories is then compared to the equivalent shares in the US S&E labour force, the latter being calculated on the basis of NSCG data (National Survey of College Graduates). Two-tail Chi-square tests prove that in all cases but one the foreign-born are over-represented in the eminent scientist and innovator group. In a few cases, a cohort effect is detected, with foreign-born people who entered the USA before 1945 being particularly productive (this is not the case, however, for top inventors and academic entrepreneurs). Finally, the foreign-educated are found to contribute disproportionately to these results, which suggests both that the USA benefits from positive externalities generated by foreign countries and that immigrant scientists and engineers self-select on the basis of skill. Recent work by No and Walsh (2010) confirm this evidence, at least for inventors.
Stephan and Levin’s results on the contribution of foreign-born scientists and engineers to entrepreneurship are confirmed for more recent years by a number of surveys conducted by Wadhwa et al. (2007a, 2007b, 2007c). The authors find that around 25 per cent of all engineering and technology companies established in the USA between 1995 and 2005 were founded or co-founded by at least one foreign-born person. The percentage increases remarkably in high-tech clusters such as the Silicon Valley (52 per cent) or New York City (44 per cent). These foreign entrepreneurs are mostly found to hold doctoral degrees in S&E, and to be better educated than control groups of natives.

Immigrants’ exceptional contribution to patenting has been further confirmed, for a large sample of college graduates, by Hunt (2009, 2013) and Hunt and Gauthier-Loiselle (2010). This depends chiefly on a composition effect, the foreign-born graduates being more likely to belong to S&E disciplines. In addition, it is confirmed that the foreign-born graduates who hold an advantage over natives got their PhD in their country of origin. However, Hunt (2009, 2013) shows that engineering and computer science graduates from the least developed countries face difficulties in getting an engineering job or in reaching managerial positions, being impeded by lack of language skills or social capital. On the contrary, immigrants from richer countries or Anglophone ones (such as India) are more common among foreign-born people actually working as engineers.

Chellaraj et al. (2008) make use of a production function approach to estimate the impact of both foreign-born \textit{hs} workers and international students on innovation in the USA. The elasticity of patents to the presence of skilled immigrants is found to be positive and significant, and even more so the elasticity with respect to foreign graduate students. This difference can be explained by the composition effect we discussed above: while \textit{hs} immigrants comprise many professions, foreign graduate students in the USA are concentrated in S&E and therefore have a much more direct impact on innovation.\footnote{A partial exception to the US-centrism of the literature examined so far is the study by Niebuhr (2010), which focuses on cultural diversity (proxied by the share of foreign-born people) in research and development (R&D) employment, as opposed to total employment, as well as in other professions classified as \textit{hs}. She then investigates the effect of cultural diversity on the patenting rate of 95 German regions over two years (1995 and 1997), finding a positive association. Other studies of the impact of cultural diversity on innovation and growth are those by Ottaviano and Peri (2006), Ozgen et al. (2011), Nathan (2015) and Bellini et al. (2013), all based on an innovation production function approach.

A growing number of papers exploit new techniques of ethnicity identification based on the analysis of names and surnames, which can be applied to archival data. The most comprehensive enquiry based on this technique has been conducted for the USA by William Kerr, in a series of papers based on the National Bureau of Economic Research (NBER) USPTO Patent Data File (Hall et al., 2001).

Descriptive analysis by Kerr (2008c) reveals several stylized facts, most of which are coherent with those concerning \textit{hs} and scientific migration:

1. The ethnic inventors’ share of all US-resident inventors grows remarkably over time, from around 17 per cent in the late 1970s to 29 per cent in the early 2000s, that is, in the same order of magnitude of CDH estimates of the foreign-born share of doctoral holders.
2. The fastest growing ethnic inventor groups are the Chinese and Indian ones, while their overall growth appears to be stronger in science-based and high-tech patent classes.

3. When distinguishing patents according to the institutional nature of the applicant (academic versus business) it appears that the growth of ethnic inventorship occurred first in universities, with firms catching up later (coinciding with the rise of the phenomenon of ethnic entrepreneurship described above).

4. Ethnic inventors appear to cluster in metropolitan areas (with a correlation between city size and percentage of ethnic patents), thus contributing to the growing spatial concentration of inventive activity observed in the USA over the past 20 years (this evidence is reprised in detail by Kerr, 2009; see also Rodríguez-Pose and Wilkie, Chapter 3, this volume).

Based on the same technique and on patent applications filed at the European Patent Office (EPO), Breschi et al. (2014) also identify inventors of foreign origin in several R&D-intensive European countries (plus Japan and South Korea). The authors then run a series of regressions aimed at testing the hypothesis of foreign inventors’ superior productivity, as measured both in terms of number of patents and citations received by patents. Their findings confirm the overall positive impacts of inventors of foreign origin on host countries’ innovation and the skill-based self-selection of these inventors. However, while the results for the USA and Europe as a whole appear similar, the results appear more nuanced when examining individual European countries. In small European countries, such as Sweden and Switzerland, where the presence of foreign inventors is massive, no strong self-selection effect is detectable. The same applies to Italy, for opposite reasons (the country is generally unattractive for R&D workers, witness the very low number of foreign inventors). As for France, Germany and the Netherlands, not all entry cohorts appear to exhibit superior productivity. This suggests that other forces besides self-selection are at work that push foreign inventors to immigrate, such as political shocks (for example, the end of restrictions to emigration from former Soviet bloc countries in the early 1990s or family reasons). The only European country whose patterns are very similar to those of the USA is the UK.

23.4 MIGRATION AND INNOVATION IN ORIGIN COUNTRIES: ‘KNOWLEDGE REMITTANCES’ FROM HS MIGRANTS

A long-standing tradition of emigration studies has consisted in evaluating the type and extent of positive returns from emigration for origin countries. Early studies laid special emphasis on emigrants’ financial remittances and the role they might play in capital formation in less favoured countries and regions. However, with the increasing importance of hs migration, the emphasis has shifted to migrants’ contribution to knowledge formation and innovation. These ‘knowledge remittances’ may come in three overlapping forms, namely:

1. ‘Ethnic-bound’ knowledge spillovers. Emigrant scientists and engineers may retain social contacts with former fellow students or educational institutions in their...
home countries, and transmit to them the scientific and technical skills they have acquired abroad (either on a friendly or contractual basis, through visiting professor programmes, research collaborations or as consultants).

2. Returnees’ direct contribution. Emigrant scientists and engineers who have worked as academic or industrial researchers may decide to move back to their origin countries and continue their activities over there. In the case of entrepreneurs, they may maintain a base in the destination country, but set up new or subsidiary companies in their home country (Meyer, 2001; Wadhwa, 2009a, 2009b; Kenney et al., 2013 and references therein).

3. Diaspora networks. Emigrant scientists and engineers working abroad may decide to come together as an associative platform, in order to establish collaborative links with their respective home countries or regions. The main goal of such networks is to channel knowledge back home. Most of them are formed by host migrants from emerging and developing countries. Some of these networks are even supported or initiated with the collaboration of sending countries’ governments, while others operate informally and yet fulfil the original intent, which is knowledge exchange (Pyka, 1997).

While case studies of these phenomena abound, large-scale quantitative evidence is scant, and largely based on patent data and (mostly) name analysis techniques. The earliest patent-based contribution comes from Kerr (2008a), who measures knowledge flows using citations running from patents filed at the USPTO from outside the USA (in years 1985–97) to patents filed up to ten years before by US residents. Citations are grouped according to four criteria (inventor’s ethnicity and technological class of the citing patent, plus inventor’s ethnicity and technological class of the cited patent). Co-ethnic citation groups (in which the country of origin of the citation and of the cited inventor coincide) are found to be on average 50 per cent more numerous than mixed ones.

Kerr (2008a) further uses patent data as regressors in a first-difference panel data econometric exercise concerning origin countries of immigration into the USA. Here the dependent variables are alternative measures of economic growth. He finds that a one percentage point increase in ethnic patents in the USA is associated with a 10–30 per cent increase in the country of origin’s output measures. The result weakens, but persists, when China is excluded from the origin country set, and when Computers and Drugs are excluded from the technologies considered. This suggests that ethnic-mediated spillovers, while having a stronger impact in high technologies and in one particular economy, are not irrelevant for a more general set of countries and technological fields.

Kerr’s (2008a) pioneering results can be interpreted by recalling the vast economic and sociological literature on the tacit nature of technical knowledge and the roles of social ties (Jaffe et al., 1993; Breschi and Lissoni, 2009; Miguelez, 2014). A straightforward application of this perspective considers co-ethnicity as a social bond between inventors, which favours the transfer of tacit knowledge assets not comprised in the patent description, but necessary to the understanding and development of the invention.

Agrawal et al. (2011) explore this possibility by assembling a database of ethnic Indian inventors of USPTO patents, all residents in the USA between 1981 and 2000, and find evidence that inventors’ co-ethnicity increases the probability of observing a patent citation, especially for inventors who are not co-located in space. However, when the
same authors extend the analysis to citations flowing from India to the USA, evidence for a role of ethnic ties weakens considerably, with the partial exception of Electronic technologies. Alnuaimi et al. (2012) and Almeida et al. (2014) likewise do not find strong evidence in this direction.

Breschi et al. (2015) extend this approach to migrant inventors active in the USA who have Asian countries of origin other than India, and to several European countries. In particular, they find that ‘diaspora’ effects do not necessarily translate into ‘brain gain’ effects for the migrants’ countries of origin. Indeed, while migrant inventors from the same country of origin may have some advantage in accessing knowledge produced by their fellow migrants, this does not necessarily translate into easier access to the same knowledge by inventors active in the home country.

In a similar fashion, Foley and Kerr (2011) exploit Kerr’s (2008a) database to investigate the specific role of ethnic inventors in relation to multinational companies’ (MNCs) activities in origin countries. They find that US multinationals with a high share or quantity of migrant inventors’ patents invest and innovate more in their ethnic inventors’ countries of origin, while at the same time relying less on joint ventures with local companies for doing so. This suggests that migrant inventors act as a substitute of local intermediaries, thus diminishing their companies’ costs of engaging in foreign direct investments.

Miguelez (2014) studies how migrant inventors in industrialized countries help increase the internationalization of inventive activity in their countries of origin. Migrant inventors are identified on the basis of information on their nationality, as provided by patent applications filed according to the Patent Cooperation Treaty (PCT) procedure from the period 1995 to 2011. Using a gravity model, the author finds evidence of a strong and positive relationship between international collaboration in patenting activities between pairs of developing-developed nations and the stock of migrant inventors from that particular developing nation living in the host developed nation. More precisely, a 10 per cent increase in the inventor diaspora in a given high-income economy leads to an average 2.1 per cent increase in international patent co-inventorship between that economy and the home economy.

Studying knowledge remittances through patent data has several limitations. Patents tend to be more representative of knowledge fields whose absorption requires extensive R&D efforts. In several countries of origin of migrants, few if any firms can afford to invest heavily in R&D or produce non-trivial numbers of patents. In the same countries, however, public funding of scientific research may sustain the publishing activity of several academic researchers, which suggests that publication data could better capture knowledge absorption through migration (Velema, 2012). Publication-based studies, however, are still very scarce. Interesting evidence of foreign-born scientists’ high propensity to collaborate with colleagues from their home countries and fellow expatriates is provided by Scellato et al. (2012) from a study based on the GlobSci survey. This study suggests that, at least within academic science, some ‘ethnic’ networks are at work, with the potential to deliver knowledge spillovers to origin countries. This means these networks are connected by linkages that expand far beyond host countries’ boundaries to home countries. Based on a survey of 497 foreign researchers in Italy and Portugal, Baruffaldi and Landoni (2012) find that the probability of high productivity and of returning home is higher for researchers that maintain linkages with home. And even after returning home, researchers still carry on their scientific activities and maintain
their ties with social and ethnic networks (Jonkers and Tijsse, 2008; Jonkers and Cruz-Castro, 2013).

A number of qualitative contributions provide in-depth descriptions of the role played by diaspora networks in home countries’ innovation (Brown, 2002; Barré et al., 2003; Kuznetsov, 2006). Meyer and Wattiaux (2006) identify 158 networks of hs immigrants from developing countries worldwide. One key finding that emerges from these qualitative studies is that positive impacts of diaspora networks in their homelands are strongly connected with the direct and indirect participation of hs expatriates in their home countries’ innovation activities through technology and skills/knowledge exchange platforms, such as innovation fairs, periodic summits, conferences and workshops held in their homelands (Adepoju et al., 2008). The indirect – and part of the direct – contribution of the hs diaspora is not necessarily captured by patent data. This might explain the contrast between results from studies of patent citations and those from studies of publications and collaborations. Furthermore, while returnees and hs diaspora members in origin countries do not always act as a direct source of knowledge transfer, they may still support foreign investments in their home countries through indirect activities such as references, advice and brokerage. This is particularly true for intra-company mobility within MNCs, which remains a grey area in the literature on the mechanisms linking hs migration to innovation.

23.5 INTERNATIONAL MOBILITY OF HS WORKERS WITHIN COMPANIES AND INNOVATION

Most of the literature reviewed so far has focused on specific categories of hs migrants, namely, researchers, academics and inventors. However, there are other groups of migrants that might play a role in cross-border knowledge diffusion. These are the professionals contributing to international, intra-company mobility, also known as business migrants or expatriates. Indeed, transfer of knowledge or skill, either within the company or beyond it, is usually the main motivation behind intra-company mobility. And in this case, the nature rather than the level of skills seems to matter the most, in so far as intra-company migrant workers encompass a myriad of professionals and education levels – executives, managers, engineers, technicians . . . – as compared to the more homogeneous groups of researchers, academics or inventors. Migration scholars have not yet devoted much attention to this (Bozkurt, 2006, pp. 214–15). Furthermore, little is said about how the dynamics resulting from such mechanisms translate into innovation. This is partly due to the fact that international intra-company worker mobility fits into a wide range of disciplines – the sociology of migrations, human geography, the theory of organizations, international economics and human resources management (Peixoto, 2006). It therefore becomes more challenging to find the right approach for tackling it. In addition, the intra-company phenomenon is more complex and dynamic than the spontaneous or strategic decisions of migrants, who choose one destination country over another on the basis of factors that are fairly well understood, making their movements easier to capture. Within companies, the direction of knowledge flow is considerably harder to identify since MNC workers could be sent abroad to a company branch, either from their home country or from another host country.
In general, the literature on the topic of intra-company migrants and their contribution to knowledge diffusion often falls outside the realm of the economics of migration or of innovation, falling into management studies instead (see Bonache and Brewster, 2001; Bjorkman et al., 2004). Most existing studies on this question address it from the firm’s perspective at the expense of a workforce approach centred on migrants themselves, the latter being the main actors of intra-company mobility. They carry with them skills/knowledge that require face-to-face interaction for transmission – tacit knowledge (Rodriguez, 2002, p. 603). These studies have centred on the management of knowledge transfer from MNC headquarters to subsidiaries, or on transfer within ‘transnational communities’: in other words, the object of study has been the social network – built on inter-personal relationships – developed within the company and across national boundaries (Lowendahl et al., 2001; Morgan, 2001; Beaverstock, 2004). There are few studies that examine topics relevant to migration and innovation within MNCs. For instance, Ozgen et al. (2013) find that diversity of culture and past experience amongst top management teams (TMT) are positively associated with firm innovation. This implies that the experience accumulated by migrants in the course of their interactions with locals, associated with their different backgrounds, could be a great asset to the firm. Similarly, a positive impact of TMT cultural diversity has been found on firm performance and on the internationalization of firm activities (Heijltjes et al., 2003; Greve et al., 2009).

Notwithstanding these results, the small number of studies that examine intra-company international mobility may be due to the small absolute size of these flows, though globalization has increased them. Another reason for this lack of interest could be the absence of systematic large-scale data on this category of migrants. The few existing studies rely on surveys – this comes with all the limitations attached to data collected this way, such as data infrequency and relatively small sample size. There are, however, some striking observations that emerge.

The first of these observations is that MNC workers who migrate, within the same company, from a developing to a developed country often do so in response to a scarcity of local specialists in the developed country. This scarcity of local specialists may be a consequence of the comparative advantage local workers have in entering other specialities or in entering professions that demand socio-cultural skills and knowledge as opposed to technical skills, as mentioned above when discussing US citizens. These technical migrants belong to the category referred to as “International Staff” by Perkins (1997), and are often the target of selective immigration policies in developed countries. Indeed, in view of the positive impact specialist migrants can have on their economy, many developed nations have adopted specific policies in order to ease their inflow. The ‘Green Card’ introduced by the German federal government in 2000, for instance, has helped the country cope with increasing demand for specialists, particularly in the information technology (IT) sector (Burkert et al., 2008): but the biggest beneficiaries of this programme were probably German MNCs, as they were encouraged to fill vacancies in skilled positions by transferring IT specialists from branches in developing countries to headquarters in Germany. Meijering and Van Hoven (2003) present evidence of this in their study of 22 Indian IT professionals who migrated to Germany under their companies’ internal transfer system. A similar analysis was conducted by Burgers and Touburg (2013) for a group of Indian IT professionals based in the Netherlands, and who were recruited internally from India within the French company Capgemini. In both studies
the authors find that transfer to Europe was mainly motivated by a shortage of highly qualified local software specialists.

Another observation that emerges from the literature is that, unlike intra-company mobility of workers from developing to developed countries, which responds to a given demand in a specific field, intra-company mobility of workers from developed to developing countries is motivated by the need to transfer skills or expertise to the firm’s subsidiaries in the destination country. In such situations, the terms ‘expatriate’ (Tan and Mahoney, 2006) or ‘Parent/Headquartered Staff’ (Perkins, 1997) will be commonly used, in reference to the direction of the flow. MNCs use different approaches to managing the knowledge transfer on which depends the successful assimilation of ‘expatriated’ knowledge by locals within the subsidiary. One of these approaches relates to cases where the skills and expertise of managers from MNC headquarters are only used at the very initial phases of a project. With the help of on-the-job training and face-to-face meetings, skills and expertise are passed on to local employees (see Martins, 2011 for the case of Mozambican subsidiaries). This appropriation of skills and expertise by locals constitutes one of the main differences between intra-company mobility of HS workers from developed to developing countries and intra-company mobility in the opposite direction. Indeed, as noted above, local workers from developed countries might deliberately choose not to acquire certain skills (focusing on others deemed more valuable) while for workers in developing countries skill scarcity is more often attributable to lack of resources than to choice. There are, however, cases where MNCs transfer many country nationals to their developing country branches in order to assert control over these subsidiaries. This is likely to result in low communication and exchange with local employees, who are often maintained in low skilled jobs. Such an approach could have the contradictory effects of transferring some new knowledge to specific locations while concurrently widening the skill gap between local workers and those at headquarters. Case studies have shown such practices to be common within Japanese MNCs (Barlett and Yoshihara, 1988; Kopp, 1994; Harzing, 2001).

Although international mobility of HS workers within MNCs often translates into some new knowledge or skills being introduced into the receiving headquarters/subsidiaries, its impact on the innovative capacities of host developing countries, and on their development in general, remains unclear. Indeed, there have been controversial debates regarding the capacity of expatriates to diffuse knowledge to local workers and firms in developing countries. As pointed out by McAusland and Kuhn (2011), new ideas or knowledge are mainly relevant in the country of production of these skills/knowledge. This implies skills/knowledge carried by expatriates may not match with the needs and skills of local firms, and so will remain strictly within the MNC’s ambit. Admittedly, the first motivation of MNCs when engaging in international transfer of HS workers is far removed from the goal of stimulating innovation or development in host developing nations. Their principal purpose is to ensure the dissemination of knowledge within the company – an essentially technical and business security strategy – in keeping with the MNC’s process and ‘know-how’ policies (Galbraith and Edstrom, 1976; Hocking et al., 2004; Thomas, 2008). However, by restricting oneself to this line of reasoning, one risks narrowing the approach to knowledge diffusion by omitting the possibility of assimilation by local firms of the knowledge initially destined for MNCs, and of its adaptation to local needs under the constraints imposed by these firms’ absorptive capacities (Romer,
Migration and innovation: a survey of recent studies  393

1996; Mansfield and Romeo, 1980; Ikiara, 2003). This is particularly the case when MNC R&D functions are decentralized to the subsidiaries: in such cases it is reasonable to infer some knowledge spillovers to local firms (Sanna-Randaccio and Veugelers, 2007).

23.6 CONCLUSIONS AND FURTHER RESEARCH

Once the preserve of research in development economics, the study of *hs* migration has increasingly attracted the interest of innovation scholars. Quality data developed from censuses and labour force surveys have become increasingly available, from which *hs* migrants can be identified on the basis of education levels. Statistics from these data depict European nations as the largest *hs* migrant-sending countries, while they lag far behind the USA as *hs* migrant-receiving nations. Innovation scholars have also produced more targeted data such as those on academics, doctoral students and inventors, which have allowed researchers to jointly address migration and innovation questions in an empirical setting. The impact of *hs* migrants on destination countries is found to be positive, as measured by productivity, patenting and scientific publications. Although the literature mainly focuses on the USA, there have been some cross-country studies of European countries that find similar results.

As for the impact on source countries, the literature’s US-centrism has biased research towards countries whose *hs* migration to the USA has grown most in recent years. By and large, these are China, India and other East Asian countries, all of which are developing countries. We know much less about migration to the USA from other developed nations, such as European ones. This is especially so for studies based upon inventor data. Overall, evidence from inventors indicates that a diaspora network effect exists within receiving countries, with a high propensity for inventors of the same ethnicity to collaborate. Evidence relating to positive spillovers within their country of origin is mixed: some studies find positive results, such as *hs* migrants having a high propensity to collaborate with home country counterparts, being connected to an increase in home country economic growth, and being associated with inventive activities and MNCs’ direct investment in their home country. Other studies, while finding evidence of close ties between migrant inventors of the same origin, find that they do not automatically translate into technology transfer to the home country. The only study that examines developed countries of origin finds some evidence of knowledge flows reaching the migrants’ home country through the channel of MNCs, but not through social networks.

The diversity of data sources may explain this mixed evidence. Patent data remain most commonly used in this literature, which can be perceived as a limitation to the extent that they do not capture the indirect – nor part of the direct – contribution of the *hs* diaspora. Qualitative studies reveal that the positive impact of *hs* diaspora networks on their homeland is mainly attributable to their participation in their home countries’ innovation activities. Finally, more attention needs to be paid to intra-company migration, more particularly to the international transfer of workers with specific skills within MNCs. Most papers on this topic address questions related to firm organization theory, and come mainly from management studies. Although the primary purpose of intra-company international mobility is to transfer skills/knowledge to the headquarters/subsidiaries,
with some externalities devolving to host economies, this topic remains a grey area in the literature of migration and innovation.

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NOTES

1. DIOC stands for Database on Immigrants in OECD Countries, as the original database reported information only on immigrants to Organisation for Economic Co-operation and Development (OECD) countries. However, the most recent release (DIOC-E) and extensions in Artuc et al. (2015) also include information on immigration to non-OECD countries. For DIOC methodology, see Widmaier and Dumont (2011) and Arslan et al. (2014); data are downloadable from http://www.oecd.org/els/mig/dioc.htm. For related data, see Frederic Docquier’s website (http://perso.uclouvain.be/frederic.docquier/oxlight.htm).

2. Selective immigration policies are those that target specifically h-1 migrants. They mainly consist in allowing tertiary-educated immigrants to enter the country even before having found an occupation, and/or in reserving quotas for specific professional figures. The most notable cases are those of Australia, New Zealand and Canada. For a comprehensive discussion, see Chaloff and Lemaître (2009). For a critique, see Belot and Hatton (2012), who show that geographic and historical factors (such as physical proximity or former colonial ties between origin and destination countries, which reduce self-selectivity of migrants) might affect the skill composition of migrants as much as policies. Bertoli et al. (2016) point out that migrants’ skill may not be entirely captured by education and other observable characteristics, and that selection based only on the latter can lead to perverse effects on overall migrants’ quality.

3. In a related paper, Stuen et al. (2012) examine the impact of foreign-born (by origin country) versus native students on scientific publications (number and citations received) by 2300 US university departments. Foreign-born and local students are found to impact similarly on their departments’ publication activity and quality, which tends to suggest they are substitutable.

4. The use of patent citations to measure knowledge flows is both widespread and controversial. It originates with Jaffe et al.’s (1993) application to the theme of spatial concentration of knowledge spillovers, where it is shown that citations are more likely to occur between patents by co-localized inventors, after controlling for the spatial concentration of patents, by technological classes. This exercise has been criticized for methodological reasons by Thompson and Fox-Kean (2005). Breschi and Lissoni (2005a, 2009) and Agrawal et al. (2009) show that other types of distance between inventors, in particular social distance, matter as much or more than spatial distance. Technical issues are reviewed by Breschi and Lissoni (2005b). For a general critique of the use of patent citations in innovation studies, see Cohen and Roach (2011).

5. A detailed description of the data can be found in Miguelez and Fink (2013).

6. There is increasing ‘virtual mobility’ – as a consequence of New Information, and Communication Technologies (NICT) – as well as more business trips, which contribute to the complexity of mobility patterns (Peixoto, 1999; Salt, 2008; Collings and Scullion, 2009; Salt and Wood, 2012). It is therefore difficult to capture the information exchanged – whether amongst a MNC’s mobile h-1 workers, on the one hand, or between them and locals, on the other: consequently, it is difficult to grasp the connection between mobility of these workers and innovation. Also, the low duration that characterizes such intra-company international movement contributes to the reluctance of some migration scholars to qualify them as migration flows.
REFERENCES


24. The geography of innovation in multinational companies: internal distribution and external embeddedness

Jannika Mattes

24.1 INTRODUCTION

A considerable amount of scholarly research is concerned with the internal organization of multinational companies (MNCs). These contributions highlight the inherent spatial tension within MNCs: on the one hand, they are active in multiple countries and consequently disperse their activities; on the other hand, the need to control and coordinate makes concentrated settings attractive. This applies particularly to strategically important and complex tasks, above all to innovation projects.

A second, separate strand of literature is concerned with corporate innovation and its external environment. This strand of research analyses the external connectedness and embeddedness of companies and their innovation projects. Again, spatial characteristics play an important role. Contributions from this line of research are concerned with agglomeration effects, the creation of clusters and the existence of regional innovation networks. With regards to innovation, they ask to what extent spatial proximity matters for knowledge transfer, learning and to generate a ‘creative atmosphere’.

Surprisingly, very few contributions integrate these two strands of research, even though they are interdependent. Attractive external networks affect the organization of internal networks, and high-level corporate activities bring with them qualified labour, which simultaneously affects the corporate surroundings (see Breschi et al., Chapter 23, this volume). It is therefore worthwhile to look at the innovation projects of MNCs from the internal and the external perspectives simultaneously.

This chapter focuses on the way MNCs organize the internal and external geographical setup of their innovation projects. ‘Geography of innovation’ is defined as the spatial allocation of innovation activities, whether within the corporation or outside. It looks at the geographical constellation in which corporate innovation is carried out. MNCs are particularly interesting entities to study in the context of the geography of innovation since they consist of several establishments and thus have the possibility to disperse their innovation activities widely. The core thesis of this chapter is that innovation is socially embedded, which is why the activities involved cannot take place anywhere. Instead, their spatial allocation depends upon social phenomena that are outlined in the following.

This chapter first focuses on the internal dimension of the geography of innovation in MNCs. It then highlights the external embeddedness of MNCs and their relationship to regional surroundings, and concludes that the geographical setup of MNCs takes place within a web of tensions. Drawing both arguments together, an empirical example shows that neither internal nor external geographic constellations are stable and uniform across a MNC. Instead, by differentiating between projects and functions, the selective
and dynamic aspects of the geographical configuration of corporate innovation are displayed. The chapter closes with a short conclusion.

24.2 THE INTERNAL PERSPECTIVE: DISPERSAL AND CONCENTRATION OF INNOVATION IN MNCS

Internally, MNCs differ from purely nationally oriented companies. MNCs are regarded as ‘drivers of globalisation’ (Gerybadze, 2004; Rugman and Verbeke, 2004). Their very definition implies dispersal: they ‘engage(s) in foreign direct investment (FDI) and own(s) or, in some other way, control(s) value-adding activities in more than one country’ (Dunning and Lundan, 2008, p.3). These companies are not concentrated, and adopt network-like structures (Criscuolo and Narula, 2007).

While much of the research that deals with the spatial setup of MNCs looks at whole companies, the focus here is specifically on innovation. Innovation is a particularly interesting phenomenon from a spatial perspective: it is among the most critical activities of modern companies – alongside responsibility and power – and the strategic importance of these activities implies a certain reluctance to decentralize them. Innovation is defined as ‘new creations of economic significance of either a material or an intangible kind. They may be brand new but are more often new combinations of existing elements’ (Edquist, 2001, p.219). The development of such new products involves all steps in a corporate value chain, and is only completed with the product’s successful marketization.

Patel and Vega (1999) had observed the development of polycentric R&D structures. Foreign research departments are getting more involved in corporate innovation processes (Zedtwitz and Gassmann, 2002). This facilitates distributed innovation processes carried out in several competence centres (Chiesa, 2000), which is why MNCs seem to be particularly well equipped for the creation of new knowledge (Regnér and Zander, 2011). Besides the classic aims of obtaining access to new markets and resources (Kuemmerle, 1997), dispersal spreads risks and increases the possibility of fulfilling different regulatory requirements (Porter, 1986a). International diversity amongst subsidiaries can be understood as a ‘valuable source . . . of variation and creation’ (Regnér and Zander, 2011, p.823), especially as the MNC provides a shared socio-organizational framework that facilitates knowledge exchange (see also Mattes, 2012a). All in all, most current research shares the idea that MNCs ideally evolve into networks of expertise and knowledge, in which subsidiaries have continuous access to each other’s resources and can therefore afford to differentiate and specialize (Almeida and Phene, 2004). Perlmutter’s (1969) geocentric firm, Hedlund’s (1994) heterarchical N-form corporation, Doz et al.’s (2001) metanational company, Doz and Prahalad’s (2005) diversified MNC, Sölvell’s (2003) multi-home-based corporation and Bartlett and Ghoshal’s (1989) transnational company all share these basic characteristics. Rather than representing unitary organizations, MNCs are ‘interorganizational groupings’ (Ghoshal and Bartlett, 1990, p.604). This more complex organizational constellation also entails the necessity of applying a wider
The geography of innovation in multinational companies

variety of coordination mechanisms. The corporate strategy of MNCs is thus a combination of holistic and atomistic elements, focusing both on the company as a whole and the individual subsidiaries (Porter, 1986b; Holtbrügge and Berg, 2004). A subsidiary needs to achieve integration between its own, local, interests and the overall strategy (Kuemmerle, 1997), which means that MNC subsidiaries are ‘dually embedded’ in their internal networks and their external surroundings (Michailova and Mustaffa, 2012, p. 392). The specific structure that a MNCs assumes, however, is not so much a strategic choice as the result of path-dependent developments (Bélis-Bergouignan et al., 2000).

The dispersal of corporate innovation just outlined is not, however, automatic. Some subsidiaries remain isolated from corporate knowledge exchange (Tsai, 2001; Monteiro et al., 2008). Conversely, innovation can be concentrated within a single subsidiary: indeed, most companies maintain critical innovation activities in their home country (Patel and Pavitt, 1998; Sanna-Randaccio and Veugelers, 2003; Dunning and Lundan, 2008; Heidenreich et al., 2012), whereas only peripheral, less important activities are arranged in a more dispersed fashion (Sölvell and Zander, 1995). In this way, the production of new knowledge remains – according to patent analyses – concentrated in corporate homelands (Archibugi and Michie, 1995), even in sectors characterized by high degrees of internationalization (Duysters and Hagedoorn, 1996).

An empirical study by Pries (2002) likewise shows that the learning expected between subsidiaries does not occur. Instead, learning remains limited to functionally differentiated entities, and communication and knowledge transfer take place within the boundaries of single subsidiaries (see also Gammelgaard et al., 2004). Since knowledge integration is a social process (Hislop, 2003), internationalized settings and the different contexts in which actors are rooted render it much more difficult (Macharzina et al., 2007). Furthermore, institutional, political, cognitive and motivational obstacles between subsidiaries limit their ability and willingness to share knowledge (Cantwell and Mudambi, 2004; Gammelgaard et al., 2004; Dunning and Lundan, 2008). In this manner, globally dispersed projects are complex with regard to behavioural topics such as project commitment and communication, but also project management, goal achievement and budget and task distribution. They tend, however, to be more creative than co-located ones (McDonough et al., 2001).

Concentration of activities, in contrast to dispersal, entails a higher level of control over the whole process (Bartlett and Ghoshal, 1989; Asakawa, 2001), and simultaneously facilitates intense face-to-face interaction in dense networks of mutual learning (Storper and Venables, 2004; Weterings and Boschma, 2009). Besides the merely geographic view, which emphasizes the reduced time and effort needed for interactions to occur, a concentration of activities usually implies a greater similarity of framework conditions: similar contexts and shared values are powerful triggers for mutual learning (Forsgren et al., 2005; Westney, 2005) based on local ‘buzz’ (Bathelt et al., 2004). Moreover, economies of scale, property rights and reduced coordination costs are efficiency-related arguments in favour of concentration (Porter, 1986a; Chiesa, 2000): concentration provides a means of cost reduction (Malmberg, 1995).

The tension just outlined, between global dispersal – to meet all market needs and integrate knowledge from all over the world – and local concentration – to maintain control and reduce coordination costs – is a theoretically unsolvable dilemma for MNCs. While a dispersed setup is critical for MNCs to gain access to markets and knowledge for successful innovation projects, loss of control favours more concentrated settings. Even
in dispersed projects, knowledge and control often remain more concentrated than the dispersal of activities actually suggests (see Mattes, 2010). Thus, the internal organization of innovation within MNCs is not automatically dispersed. We shall now look at the external dimension.

24.3 THE EXTERNAL PERSPECTIVE: GLOBALIZATION AND REGIONAL EMBEDDEDNESS OF CORPORATE INNOVATION

As outlined in the previous section, MNCs aim to reach world markets and to benefit from world knowledge, both of which are crucial reasons for internalizing R&D activities (Kuemmerle, 1997, 1999). At the same time, no matter where they are located, MNCs act in institutional and social contexts to which they have (more or less explicit) links (Mattes, 2010; Heidenreich, 2012a; Heidenreich et al., 2012). This section outlines the institutional embeddedness of MNCs and then focuses on their most direct surroundings, the regional setting. It thereby stresses the extent to which the geography of innovation in MNCs remains embedded in society and, as a consequence, bound in space.

The concept of embeddedness (Granovetter, 1985; Uzzi, 1997; Polanyi, 2001 [1957]) stresses the interdependencies between actors and their environment as socially interrelated action spheres. High embeddedness rests upon a certain degree of institutional ‘fit’ between the company and its environment, that is, the regional surroundings adapt to the MNC’s needs and/or the MNC designs its activities according to regional conditions, either of which implies indirect interrelations between MNC and region: embeddedness implies mutual adaptation and interaction (see Andersson et al., 2002). Additional, stronger embeddedness can be based on direct links, interaction and interdependencies between the MNC and other actors in the region. Thus, the term ‘embeddedness’ refers to tangible and intangible relationships between MNCs and their regional surroundings, resulting in an actor-specific network view of regional settings. Disembeddedness, on the other hand, is defined as the absence of such links and a lack of institutional fit between the MNC and its regional environment. In contrast to regional embedding, it allows for independence to be maintained, for intra-corporate networks and resources to be focused upon (see Zander and Sölvell, 2004) and for independence from particular regional settings.

While the embeddedness of MNCs is generally studied implicitly in research on both international business and economic sociology (Heidenreich, 2012b), it has been taken up explicitly in a recently published reader on the institutional context of MNCs and their innovation activities (Heidenreich, 2012a). The authors of that volume show that the embeddedness of innovation in MNCs leads to dilemmas, which can be partially resolved by combining intra-corporate and external factors, something that strategic socially skilled actors either facilitate, foster or hinder and that can lead to the emergence of stronger regional or national links (Mattes and Heidenreich, 2012). Embeddedness combines proximity factors, available institutional factors, local collective competition goods and access to local services (Heidenreich and Mattes, 2012). While drawing upon these advantages involves a corporate decision (Hancké, 2012), it is at the same time dependent upon external actors fostering interconnectedness (Sölvell, 2012). Moreover,
The geography of innovation in multinational companies

The fit between a company’s activities and its institutional surroundings plays an important role (Iammarino et al., 2012). At the same time, an embedding strategy can be risky as it endangers the company’s independence (Heidenreich and Mattes, 2012).

It can be shown that embeddedness emerges from the interplay of political willingness, path dependence and strategic decisions (Barmeyer and Krüth, 2012). It is hence described as a ‘selective, constructed and dynamic process’ (Mattes and Heidenreich, 2012, p. 339), that is, not all corporate activities are embedded to the same degree, it is not automatic but depends upon strategic and emergent actions, and it changes over time.

Turning now to the geography of innovation in MNCs, the concept of embeddedness suggests both direct and indirect links between corporate innovation and its direct surroundings (Mattes, 2010; Heidenreich et al., 2012). The embeddedness of MNCs, when it occurs, shows that even transnational activities remain geographically bound (Koschatzky and Baier, 2012). The most direct embeddedness is that within small-scale regions. Regional economic activity does not result merely from a cluster of firms co-locating there. It is necessary that an institutional infrastructure of scientific, political and intermediary subsystems complement these clusters (Asheim and Isaksen, 2002): firms constitute a particular subsystem focusing on the application and exploitation of knowledge, whereas the institutional framework focuses on knowledge generation and diffusion (Autio, 1998; see also Cooke et al., 2000).

The phenomenon of interdependence between companies and regions has, so far, mainly been analysed with reference to institutional contextual factors. However, a closer look displays two levels of interaction between innovation in MNCs and regions. First, embeddedness takes place at an institutional level, which means that there are general influences that affect internal innovation processes and that lead to the regional affiliation of the subsidiary as a whole: this refers to the institutional fit between the MNC and its regional surroundings. The more neglected second level of embeddedness concerns specific innovation projects, where regional connections are achieved through the direct participation of cooperation partners in corporate innovation projects. When innovation projects and their embeddedness are explored, both the project-specific and the institutional levels of embeddedness need to be considered, as they combine into a nuanced complete picture of embeddedness.

The institutional level of embeddedness refers to the MNC’s overall fit into, and connectedness with, its regional surroundings. Even though there are no direct project-related relationships involved, these institutional links nevertheless represent those that may result in the embedding of specific innovation projects. Links with different spheres can be present, such as with the educational and scientific spheres, the industrial sphere, the political sphere and with intermediaries. Additionally, infrastructural factors and the ‘industrial atmosphere’ play a decisive role (Marshall, 1919, p. 284; Asheim, 2000).

On this institutional level, there is tension between MNC embedding and disembedding. Embedding in the region allows a MNC to exploit collective goods and draw upon external knowledge and competences. As knowledge and expertise are important resources for corporate innovation, and as both factors are not exhaustively available internally, they may also be obtained through local universities and scientific institutes (see, for example, Etzkowitz and Leydesdorff, 2000; Etzkowitz, 2001). At the same time, regional embeddedness poses a threat to the MNC. Mutual interdependencies between large companies and their regional surroundings emerge, and these raise the danger – for
MNCs – of becoming locked into existing structures (see Grabher, 1993; Heidenreich, 2004). As regional actors orient themselves towards the MNC’s needs, regional variety decreases, and the available local collective competition goods (Le Galès and Voelzkow, 2001) cease to provide innovative inputs to the company. Regional embeddedness is thus not necessarily a positive characteristic in that it may result in lock-in situations, induce dependence upon the regional economy and narrow the scope of locally available variety.

MNCs therefore also aim at regional disembedding in order to avoid these effects. Furthermore, not adapting too strongly to its regional surroundings allows the subsidiary to maintain a global focus and to integrate more seamlessly into the wider corporate group (Bartlett and Ghoshal, 1989; Zander and Sölvell, 2004). In this manner, MNCs face a constant trade-off between acting as disembedded footloose companies at the global scale, and embedding themselves in local regional infrastructure (Kristensen and Zeitlin, 2001, 2005). Regional embeddedness is thus by no means an automatic phenomenon, but depends upon a mix of strategic choices and path-dependent evolution: companies can decide whether they are willing to invest in strong local connections, and in which regions, or whether they will maintain a broader, more global, orientation.

This problem of embeddedness is also reflected at the project-specific level of corporate innovation. At this level MNCs face a continuous struggle between cooperative and stand-alone strategies. In comparison to the vast amount of literature on companies and their relation to regions, surprisingly little has been published on specific corporate innovation projects and the extent to which they are connected to regional partners (however, see Mattes, 2010; see also Fritsch, 2001; Fritsch et al., 2007 for the role of universities). Regional partners can come from the different spheres analysed with regard to institutional embeddedness, that is, universities and scientific institutes, other companies, political institutions, chambers and labour associations. Specific embeddedness refers to the participation of such regional actors in innovation projects. While this does allow for drawing upon external resources and competences, it increases the likelihood of failure (Lhuillery and Pfister, 2009), of loss of control and of outflow of resources, knowledge and competences (see Rond and Bouchikhi, 2004). This shows that the trade-off between embedding and disembedding is also one about internalization and externalization, one about autonomy and control, and one about absorbing external knowledge and protecting internal skills.

The company-region interaction goes beyond factors of regional infrastructure and local collective goods. At the specific level, the interesting question concerns the actual exploitation of these goods and whether and to what extent MNCs draw upon these factors in the course of corporate innovation projects. This is why the embeddedness of projects should be regarded as a very direct type of regional embedding. Project embeddedness is revealed by direct interaction between project participants and other regional actors as well as by the involvement of external actors in the project. It can thus be analysed more precisely than institutional regional embeddedness. Additionally, the definition of embeddedness is stricter here: for innovation projects, ‘embedded’ suggests real and active participation in the innovation project, not a mere passive or observational role. But do internationally oriented companies ever rely upon strictly regional assets, particularly for protected core processes such as innovation projects? If regional actors are involved in these critical projects, this can be interpreted as a sign of
strong connectedness to the region (see, for example, Biggiero, 2002). However, MNCs have other options, as cooperation always implies a loss of knowledge, competence and control and hence poses a threat to the company. Disembeddedness allows the MNC to maintain control and independence and/or adopt a more global orientation. In this sense, the question of whether to regionally embed or remain detached has no simple or universal answer (see also Heidenreich, 2004).

Regional embeddedness is neither the only rational alternative for MNCs nor an automatic process. Furthermore, whether or not it is advantageous may depend upon the chosen level of analysis, which is why it is worth differentiating between institutional and project-specific embeddedness. It is, furthermore, important that embeddedness be understood not as a purely external phenomenon but also strongly dependent upon MNC’s internal structure and strategy. The following section illustrates the internal and external geographical organization of a MNC’s innovation project using an empirical example.

24.4 A DIFFERENTIATED PERSPECTIVE: PROJECTS AND ARENAS TO COMBINE SEVERAL SPATIAL ORIENTATIONS

This chapter has so far shown that innovation in MNCs generates a multitude of tensions. Theoretically, the innovation activities of MNCs need to be simultaneously concentrated and dispersed, regionally embedded and disembedded. Of course, it is difficult to reconcile these opposing requirements. However, when considering the literature, it is striking that what most studies have in common is their focus on the organization as a whole. They describe how innovation (and other) activities in MNCs are assigned to different locations and how they are rooted to their specific contexts, at most differentiating between the different functions each subsidiary can assume (see, for example, Bartlett and Ghoshal, 1990; Almeida and Phene, 2004; Forsgren et al., 2005). However, MNCs are not uniform entities. Each division and each project may have different requirements and can operate in a unique constellation (see also Mendez, 2003).

A helpful point of departure for improving our understanding of how the diverging requirements can be combined is to break down the phenomenon of ‘innovation’. It is necessary to look inside the organization in order to understand how specific activities are conducted. Even a given project need not take place under a uniform geographical constellation, that is, it does not continuously require the same spatial setup (Moodysson, 2008): each project involves different functions as outlined in the arena model by Hage and Hollingsworth (2000). Basic research, applied research, development, production, quality management and marketing all have different characteristics and requirements: this means that they can each follow different organizational structures and principles (see also Schofield and Gregory, 2004). In order to investigate specific constellations of internationalization and regional embeddedness, the following empirical example is presented to illustrate how spatial characteristics change within a single innovation project (Hage and Hollingsworth, 2000).

The example draws upon an innovation project conducted in a large MNC in the automobile industry (AutoCom) (for a more extensive introduction to the empirical material,
see Mattes, 2010, 2012b; Heidenreich et al., 2012). It concerns the search for a new drive technology and its application in buses. The project is strategically important and takes several decades. Internally, it is allocated to a special subsidiary, designated the corporate competence centre in this particular technology. The nearby headquarters are involved for serial production and for strategic support; more dispersed worldwide monitors participate in testing the new product. Several suppliers, who are external partners, established offices in close proximity to the specialized subsidiary to facilitate cooperation, but there are also dispersed worldwide test partners. With regards corporate embeddedness, AutoCom has a long history in the region where both headquarters and the specialized subsidiary are located. At the general, institutional level, regional embeddedness is high: a local university supplies specialized labour, multiple suppliers and service providers are located nearby, the city’s name is closely linked to the company’s name and political initiatives take into account AutoCom’s interests.

In the following paragraphs, we briefly outline the geographical setup and project-specific embeddedness of the different functional arenas involved.

The research for a new drive technology in AutoCom starts by drawing together all involved activities into a centre of excellence (concentration). The headquarters, located nearby, keep a close eye on the proceedings. The co-location of all the involved activities is specifically constructed and emphasizes that geographical proximity is regarded as an enabler of successful project completion – even though the project itself targets, from the outset, a world market. The MNC does not explicitly draw upon its surroundings for external research-related knowledge, which implies that the project remains regionally disembedded.

When decentralization becomes necessary – in order to include the various competences needed for development – core activities and particularly decision-making power remain strictly concentrated. Major external partners are specifically asked to establish subsidiaries close by, which shows how embeddedness is actively constructed. The project-specific embeddedness regarding these suppliers and development partners is therefore high. At the same time, internally, the project is being modularized and divided into manageable work packages. Packages that are less central to the project are delegated to other subsidiaries, where they are undertaken simultaneously but more or less independently of one another by the different partners (see Schmickl and Kieser, 2008). Thus, the dispersed internal configuration does not entail face-to-face cooperation between the additionally mobilized subsidiaries.

Production is simply delegated to another site, and production partners are regarded as mere service providers: at this stage, therefore, activities concerning the innovation remain co-located, but these co-located activities move from one location to another. Production is regarded as a fairly codifiable task and hence not tied to particular places. Regional embeddedness is likewise rather weak as the function is mostly conducted internally.

For quality control, the setting is more dispersed, involving test fleets all over Europe. However, control remains in the original sub-unit, and dispersal is treated as a ‘necessary evil’ in order to facilitate global marketing. Besides the test partners from all over the world (entailing dispersal), the regional transport provider acts as one of the test partners, facilitating project-specific embeddedness. Surprisingly, the advantages of geographic proximity are not being exploited. Instead, communication with local
The geography of innovation in multinational companies

participants follows the same standardized channels as those established with partners from all over the world: project-specific regional embeddedness is not a strategic aim, and appears to be somewhat of an afterthought.

*Marketing* is defined centrally by headquarters, and local subsidiaries in different markets make only minor adaptations to this overall strategy. Hence, the core activities are concentrated, while dispersed subsidiaries participate in specific adaptations. Regional external links are only drawn upon for selective presentations of the local test fleet, and we do not observe any strong project-specific embeddedness.

In short, the project has recourse to selective and strategic dispersal as a tool to (a) draw upon all available competences in the company and (b) facilitate market introduction with a global reach. Wherever these criteria do not make international dispersal absolutely necessary, the project remains encapsulated in a specialized site with regular face-to-face control and interaction with the headquarters. External partners are only reluctantly involved, and if they participate, they are meant to (re)locate themselves in close proximity. Table 24.1 summarizes the project’s setup.

Table 24.1 Internal and external geographical setup in a project in AutoCom

<table>
<thead>
<tr>
<th>AutoCom</th>
<th>Location of activities</th>
<th>Overall internal constellation</th>
<th>Project-specific regional embeddedness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Development</td>
<td>concentrated core: concentrated, others dispersed</td>
<td>concentration modularization (with touch of core-periphery)</td>
<td>disembedded embedded</td>
</tr>
<tr>
<td>Production</td>
<td>concentrated (in production site, Germany)</td>
<td>sequential dispersal</td>
<td>disembedded</td>
</tr>
<tr>
<td>Quality management Marketing</td>
<td>dispersed core: concentrated, country adaptation: dispersed</td>
<td>modularized dispersal core-periphery</td>
<td>cautiously embedded disembedded</td>
</tr>
</tbody>
</table>

Source: Based on Mattes (2015); own amendments.

This example illustrates what has been found in more extensive research (see, for example, Mattes, 2010): the geographical configuration of innovation in MNCs is complex. Internally, we find a surprisingly high reluctance to disperse activities beyond what is absolutely necessary, even in the ‘international’ projects that have been investigated. Dispersal is accepted as inevitable for global marketization, for meeting regulatory requirements or for following corporate rules concerning available capabilities. If it can be avoided, though, dispersal does not take place, and tasks remain concentrated in the originating units (usually the headquarters or a nearby research-oriented unit). Moreover, a more fine-scaled study would show that dispersal of activities is rarely accompanied by dispersal of power: headquarters maintains close control. Furthermore, the decision to adopt a distributed configuration is not necessarily a strategic one. Configurations often emerge in a path-dependent fashion, and these are much stronger and more resilient than those resulting from strategic decisions, if only because these decisions are (in many cases) never explicitly taken. Projects are set up in the way in which they emerge: since the initiators tend to first involve people they know, trust and meet on a regular basis, the initial setting is usually concentrated. This implies that concentration in innovation
projects tends to happen more or less automatically, whereas dispersal depends upon decisions that may never be taken.

We have further shown that concentrated setups do not necessarily entail project-specific embeddedness. While there is a very high level of general embeddedness for many MNCs, external links to corporate innovation projects are generally avoided and only cautiously drawn. Instead, innovation takes place in surprisingly impermeable single subsidiaries of MNCs. At the same time, ‘industrial atmosphere’, available infrastructure and political positioning – that is, institutional embeddedness at the general, corporate level – are of the highest importance to MNCs. This leads back to the dilemma of regional embedding: while the regions tailor themselves to meet MNC needs, the corporation itself cherishes its independence, particularly when it comes to project-specific interaction.

Overall, it can be concluded that the geographical configuration of MNC innovation is not a uniform phenomenon. Instead, it makes sense to look at individual projects and even to differentiate between functions within these projects since their geographies differ and evolve.

24.5 CONCLUSION

MNCs are complicated phenomena, and even more so is innovation in these companies. Analysing the spatial distribution of innovation in MNCs is not simple or straightforward. On the one hand, innovation in MNCs is not conducted regardless of space and place. On the contrary, space matters. This chapter has shown that the spatial configuration of innovation-related activities tends to be much more concentrated than expected. The co-location of critical activities remains a driving factor, it facilitates interaction and it helps to maintain control. On the other hand, the dispersed configuration of the MNC itself, with subsidiaries spread across various countries, means that there exist possibilities to draw upon knowledge from all over the world. As the empirical example shows, the fact that MNCs draw upon these factors in their innovation projects does not imply complete dispersal, but is instead a strategic option that can be resorted to selectively and temporarily. The global reach of MNCs is therefore of a particular nature. Dispersal rarely involves the dispersal of power, and is often sequential rather than simultaneous. This means that MNCs are not in all respects as global as we tend to think.

Similarly, a nuanced perspective is necessary for understanding the external embeddedness of MNCs. At the general level, MNCs and their innovation projects draw upon (regional) external factors such as qualified labour, infrastructure and political support. At the project-specific level, however, we do not observe the same close links. While cooperation with local suppliers, competitors, universities and scientific institutes is common, these partners are not usually involved in core innovation activities, and collaboration remains at arm’s length. Regional embeddedness is not only seen as a strategic asset, it also represents a risk of losing sovereignty and control. This means that MNCs tend to conduct their innovation projects more hermetically than the debate on regional learning and local innovation system leads us to believe.

It can further be concluded that, theoretically, the tensions between dispersal and concentration, and between external embedding and disembedding, cannot be resolved. However, this is a theoretical rather than a practical problem: managers tend to cope
with the tensions pragmatically. Regnér and Zander (2011) even suggest that the tension between local and global is above all an opportunity for MNCs, and that the aim is not to balance between one or other of these poles, but to accept the inherent diversity, uncertainty and ambiguity. It is exactly this ambiguity that facilitates knowledge creation. It can thus be considered an advantage for MNCs that they operate in various internal and external frameworks and can combine and integrate knowledge from different sources (Regnér and Zander, 2011) – even though the advantage also poses challenges.

Finally, we have shown that a consistent understanding of the geographical configuration of MNC innovation is best achieved by looking simultaneously at both its internal and external dimensions. While geographical concentration does not necessarily entail regional embeddedness (and vice versa), the interplay of the two dimensions helps to better understand the overall strategy of corporate innovation. In the example described, the strategy is to conduct as many activities as possible in-house, locked away from external influences (regardless of whether they are regionally concentrated or globally dispersed), and to draw upon external partners mainly to test the product in diverse, dispersed and representative settings. This points to the selective and sequential character of allocating corporate innovation. Innovation in MNCs does not just have one location and configuration, nor just a single geography. For understanding its geographical configurations, it is necessary to look at actual processes and analyse individual projects, even examining the functional steps occurring within them.

NOTES

1. This section draws upon prior work published as Mattes (2015); thanks to Palgrave Macmillan for the friendly permission.
2. See also Michailova and Mustaffa (2012) for an extensive overview on publications on knowledge flows among corporate subsidiaries.
4. Large parts of this section are based on prior work published as Mattes (2012b); thanks to Taylor & Francis for the friendly permission.
5. These authors combine embeddedness with a regional innovation system (RIS) approach to illustrate general and specific embeddedness. Another attempt to combine the concepts of RIS and embeddedness can be found in Cooke (2001). His study is conducted from a political perspective.
6. Kuhlmann (2001) describes these spheres as subsystems of regional innovation systems. See also Mattes (2010) and Heidenreich et al. (2012).
7. Zander and Sölvell (2004, p. 22) describe this tension between adapting to the local business environment and integrating into the internal multinational knowledge as the ‘insider-outsider dilemma’.
8. Parts of this section are based upon Mattes (2015); thanks to Palgrave Macmillan for the friendly permission.

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Part VII  Local impacts of innovation: introduction

Richard Shearmur, Christophe Carrincazeaux and David Doloreux

Literature on the geography of innovation has almost exclusively dealt with questions that pertain to where innovation occurs. A wide variety of such questions have been asked: what are the local factors and institutions that are conducive to innovation in small and medium-sized enterprises (SMEs)? What is the extent of local innovation-related spillovers? Which cities patent, in which technological classes? Where do creative people – understood as initiators of innovation – choose to live? Where do scientists travel to and exchange ideas?

Far more rarely have questions been asked that focus on the local impact of innovation. It has been assumed – not only by researchers but by policymakers – that innovation is desirable, and that, to the extent it occurs in a locality, it will benefit that locality. This assumption rests loosely on ideas derived from endogenous growth theory, that is, the idea that economic growth is driven by innovation (which is endogenous to the economic system), and that, furthermore, economic growth is beneficial to society at large.

Yet, anyone who has studied regional growth and development has been confronted with the fact that national or global growth does not always translate into local growth. Furthermore, the local presence of growth factors (such as human capital) is no guarantee that the growth factors will remain in the locality. Even more perversely, economic growth of a locality is no guarantee that every local person will benefit from it. In short, the question of distribution (or allocation) is central to any geographic analysis of the economy: without suggesting that there is a zero-sum game (one region, locality or person does not necessarily gain at the expense of another), the changes brought about by economic growth clearly benefit some places or people and can cause major upheaval for others.

These ideas are central to the study of innovation. Most students of innovation recognize the process of creative destruction: the new pushes out the old, as new technologies, more efficient production processes and better management techniques supersede older and less effective ones. Even if one accepts that this process increases social utility in the aggregate, it has been widely recognized, ever since the Luddites destroyed new textile machines in the early nineteenth century, that some people benefit from innovation while others can see their livelihoods destroyed.

Unfortunately, ‘Luddite’ has become a pejorative term used to designate people considered backward and incapable of appreciating the benefits of novelty. However, the question that Luddites raised is of fundamental importance, all the more so at a time of soaring inequality between people, and also between neighbourhoods and regions (Chen et al., 2012; Piketty, 2013).

The questions addressed in this part are: to what extent does local innovation enhance the development of each individual in the locality (Lee, Chapter 25)? To what extent does
local innovation enhance a locality’s overall development (Shearmur, Chapter 26)? And how can creativity and innovation be harnessed for the good of the community (Klein and Tremblay, Chapter 27)? Of course, each of these chapters is only suggestive, and each calls for more research. At present, apart from some fragmented contributions, for example, those by Breau et al. (2014), Lee and Rodríguez-Pose (2012), Shearmur and Bonnet (2011) and Kratke (2011), few economic geographers have attempted to empirically assess the impact that innovation and innovative activities have on localities themselves and on income distribution within those localities.

Beyond this question – which the chapters in Part VII address – lies a wider and more fundamental one. Innovation is invested with normative qualities – it is considered ‘good’. Even when its distributional consequences are questioned, its connection with economic growth (and with increased social utility) is accepted.

This normative assumption should be re-evaluated. To what extent was thalidomide desirable? Was asbestos fire-protection a good thing? Were the financial innovations leading up to the 2008 implosion of any social benefit? Is innovation that is destined mainly to enhance consumption defendable in view of current environmental problems? One response – that preserves the positive view of innovation – would be to recognize that some of these are indeed failures, but that failures are necessary downsides of innovation that further innovation can respond to. Another, more sceptical, response would be to take seriously the disastrous impacts of ill thought-through or poorly motivated innovation, and to study more closely the potential benefits and costs of specific innovations. From this perspective, innovation would be stripped of normative assumptions and treated neutrally as an activity that needs to be assessed in terms of its specific consequences rather than in terms of its generic theorized role. In the field of economic geography, this would entail first recognizing that innovation has been treated as almost unequivocally desirable, and then thinking through whether this is justified and what impact it may have had (and still be having) on policy advice derived from innovation studies.

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25. Growth with inequality? The local consequences of innovation and creativity

Neil Lee

25.1 INTRODUCTION

In the context of globalization and rapid technological change, innovation and creativity are perceived as increasingly important for economic growth. Certain cities and regions are often seen as the focal points for these processes, as they contain the critical masses of skilled workers, specialized firms and entrepreneurs necessary to develop and commercialize new ideas. Many studies consider the role of cities in innovation processes, and research has considered the influence of urban scale, skills or specific sectors on innovation and the influence of innovation or creativity on urban economic growth. However, little research has considered the relationship in reverse: while studies have considered the impact of cities on innovation, there is relatively little research on the consequences of innovation or creativity for the city itself (Shearmur, 2012).

Yet, innovation is intrinsically a disruptive activity and there are increasing concerns that the gains from innovation are not evenly distributed (Lazonick and Mazzucato, 2013; Lee and Rodríguez-Pose, 2013; Breau et al., 2014). The Schumpeterian theory of ‘creative destruction’ suggests waves of new innovations entering the market with benefits for some, but at the cost of some incumbent firms and workers. Innovation has reshaped the labour market, with new technologies substituting for mid-skilled employment and being associated with wage growth at the top of the distribution (Goos and Manning, 2007). New technology and interrelated increases in trade integration have allowed top earners to harness greater wages than before, further increasing the premium on certain skills (OECD, 2011). These workers are often located in the most innovative cities, and some have suggested that these cities are where inequality is highest (Florida, 2005; Donegan and Lowe, 2008; Lee and Rodríguez-Pose, 2013).

There is growing concern about high levels of inequality across the developed world, with authors such as Piketty (2014) highlighting the long-term growth in disparities. Inequality has increased in the vast majority of Organisation for Economic Co-operation and Development (OECD) economies over the past 30 years, even in traditionally low-inequality countries such as Denmark and Sweden (OECD, 2014). In many economies, the long-standing relationship between productivity growth and wages seems to have weakened or broken down altogether. The United States is an extreme case where real average earnings for the bottom 90 per cent of wage earners have not grown since the mid 1970s; in France and the United Kingdom there has been only slim wage growth for this group, and only in Canada has the relationship between productivity and wages been maintained (Furman, 2014). Other research has highlighted the potential negative consequences of inequality – in terms of higher crime, worse health outcomes and reduced life
satisfaction – for all those in the wage distribution, rather than simply those on low wages (Frank, 2007; Wilkinson and Pickett, 2010).

The concern that innovation may result in inequality has been increasingly felt at a local level. The most successful areas for innovation, such as Silicon Valley, are often marked by extreme inequality between rich and poor (Florida, 2005), with affluent workers in innovative sectors often creating employment for workers in personal service occupations such as security, cleaning or working in restaurants. Processes of gentrification and displacement have been observed in these cities, with affluent workers clustering in ‘creative’ areas of inner cities and previous residents priced out. Recent research has even – controversially – begun to question the assumption that growth is inevitably a positive force for living standards (OECD, 2014). This is particularly the case if the benefits are unevenly distributed to certain groups of the population, as might be the case when growth is caused by innovation, but the costs are more widespread.

This chapter considers the local consequences of innovation. It argues that innovation has some significant implications for cities and regions: it is associated with widening income disparities both within and between cities. Within cities, innovation can be associated with growing disparities between rich and poor. Similarly, while strategies focused on creativity may result in aggregate economic growth, a narrow focus on creativity can skew government policy onto the attraction of affluent newcomers and away from groups with more immediate needs. Moreover, while some cities and regions gain from innovation others either do not gain or decline as a result of technological change, so innovation may increase inequality between, as well as within, places (see Shearmur, Chapter 26, this volume). Yet, this highlights a classic tension between economic efficiency and the equitable considerations of innovation-led growth.

The chapter is structured as follows. It begins with a general view of the link between innovation and inequality, highlighting the literature on the role of innovation and new technology in changing the labour market. It also considers the recent policy and academic emphasis on ‘creativity’ and the challenges this poses. It then shows how inequality may be most acute in the cities that are most ‘innovative’ – but that innovation may also be associated with lower poverty rates in these places. It then suggests that the costs of innovation need to be set against the problems of regional economic disparities between places where there is too little innovation-led growth and those with less. It concludes with suggestions for reconciling these issues and some suggestions for future research in this area.

### 25.2 INNOVATION AND INEQUALITY

#### 25.2.1 Innovation and Economic Change

Any economically disruptive activity, such as innovation, inevitably creates winners and losers. This chapter takes a broad view of innovation, which is defined as the successful introduction of new products and processes, and creativity, which is one of the core competencies in successful innovation. Schumpeter’s classic theory of innovation suggests it will lead to creative destruction, with new products and processes taking over from the old in a process that leads to aggregate gains but may come at significant cost to some
Growth with inequality? (Bogliacino and Pianta, 2010). In this formulation, the new set of innovators is likely to gain and others will lose, but the benefits of innovation may be more widely distributed across the economy. Similarly, those losing out can be both widely dispersed or relatively concentrated.

25.2.2 Technological Change and the Labour Market

The impact of technological change on workers has been a topic of debate at least since the Luddites, English craftsmen who launched violent attacks against the new industrial machinery they felt was taking their jobs. As technological change has accelerated, a broad literature has developed that investigates the impact of new technologies – most recently, computers – on the labour market. This has focused on the potential of technological change to either complement or substitute for workers with different skill levels. Classically, these models have assumed that new technology would complement the labour of high-skilled workers, who can use computers in their day-to-day work and so raise their productivity. For example, a manager might find that email increases their productivity or a graphic designer can move to computerized design programs. But, while it may make some workers more productive, new technology will also replace the labour of others: some tasks are better (or more cheaply) performed by the new technology, and so the occupational composition of the economy will change. The implication of this model is that technological change will lead to employment polarization and wage inequality.

Yet, this basic prediction has been unable to explain the increased growth in employment at the bottom of the wage distribution in many economies, and a subtler model has replaced it: sometimes called the Autor-Levy-Murnane (ALM) hypothesis. Rather than technology replacing skilled or unskilled labour, the ALM hypothesis is that technology will replace occupations that are routine and so automatable, not occupations that rely on non-routine low-skilled tasks. Jobs vulnerable to automation are mid-skilled jobs such as book-keeping or secretarial work that are routine but require some complicated work. Employment in non-routine but low-skilled work, such as washing dishes or waiting on tables, will remain. Evidence has supported the existence of skills biased technological change in general, and the ALM hypothesis more specifically (Goos and Manning, 2007). However, there have been some criticisms of this body of work – not least the problem that occupational categories may be susceptible to change over time.

Research on the labour market impact of technological change has two main implications for work on the local consequences of innovation. First, some authors have suggested that because technological change may be more intense in particular cities and regions, these are likely to experience the most rapid hollowing out of the labour market (Breau et al., 2014). However, the extent to which the effects of technological change are specifically felt locally is unclear and it may be that innovations created in one city end up creating or destroying employment in other places. For example, a sector-specific innovation that is created in close proximity to its use, such as the introduction of a new computing system automating trades in financial services, may be locally created and have impacts on the local employment structure. But new assembly line automation that causes workers to lose their jobs in the Nissan factory in Sunderland, England, may have been created in the Nissan head office in Japan. There is, as yet, no clear theory for how the location of an innovation and its labour market impact are linked.
A second implication is more directly observable: technological change may increase the rewards to certain skills, such as advanced cognitive or creative skills (Shefer and Antonio, 2013). Workers who are more productive using new innovations will find their incomes rise – as will those working in sectors in which the new innovations are designed and produced. Cities or regions where such skilled workers tend to cluster will tend to have higher average incomes, but this will also increase inequality. Innovative cities are both likely to have more affluent innovators and the wage premium of these jobs is likely to be higher: thus, innovative cities are likely to have higher wage inequality.

A simple regression analysis can test the extent to which workers receive an innovation premium in particular cities, using cross-sectional data on individual wages and local area data such as high-tech employment share. The higher wages earned in innovative cities are not just a compositional feature, but extend to a premium for workers across the city. Echeverri-Carroll and Ayala (2009) consider the wage premium from living in a US city with a high level of tech-employment (the top 30 by industry share of 100 Metropolitan Statistical Areas (MSAs)) and show that skilled workers earn a premium in these ‘tech-cities’. In a similar study, STEM (Science Technology Engineering and Mathematics) workers tend to earn more in cities where there are higher concentrations of other STEM graduates, a finding that can be explained either by sectoral agglomeration economies or by the sorting of STEM workers into areas where they expect a high return (Winters, 2012). In short, innovative cities experience higher shares of innovative workers – but these innovative workers also earn more in these cities.

Growth in wages at the top of the distribution can have significant implications on the low-wage labour market. The ALM hypothesis suggests that technological change will lead to growth both at the top and the bottom of the wage distribution. Most non-routine, low-skilled jobs need to be in proximity to highly skilled workers. For example, office cleaners need to be located near the offices they clean. So, while there is associated employment from innovative workers, the employment is often in these low-wage jobs. Studies do suggest there are some benefits for other workers, but the benefits do not seem to be as large as those for the skilled worker or those in innovative sectors. Echeverri-Carroll and Ayala (2009) show that, controlling for worker characteristics, such as education and occupation, there is a wage premium of 4.6 per cent for workers in these ‘tech-cities’, a premium that is higher for skilled (6.2 per cent) than unskilled (4.2 per cent), and with a large premium for workers in the tech-sector (5.0 per cent). Given that other characteristics of these workers are controlled for, such studies are likely to significantly understate the actual wage disparities in these cities.

### 25.2.3 Risk and the Divergent Gains from Innovation

Beyond its role in raising wages, innovation may also increase wage dispersion in particular industries. The growth in ‘within group’ inequality has been one of the important trends in wage inequality in many countries, and some scholars have suggested that innovation may be the cause (Aghion, 2002). Successive rounds of unpredictable creative destruction can be seen as a series of near-random shocks, with workers in one firm, sector or even city gaining at the expense of others. Given the difficulties in predicting the impact of each successive wave of innovation, this can increase inequality in ways
that make natural ability irrelevant. Such shocks instead make place for a premium on adaptability (Mendez, 2002).

In the firm-level literature, there is good evidence of the risky and erratic nature of innovation. Some investments in research and development (R&D) will lead to a new product innovation and a significant return for the company; the vast majority, however, will not (Coad and Rao, 2008; Nightingale and Coad, 2014). Most attempts at entrepreneurship ultimately fail, in the medium term at least, and those firms that do succeed often do so only at the expense of their competitors. Silicon Valley is famously permissive of these failures, allowing entrepreneurs of failed companies to find alternative employment (Saxenian, 1996). Innovative cities and regions will by definition have more ‘winners’ than other areas, but they will also have many failures.

25.3 THE COSTS OF THE CREATIVE CLASS

As with innovation, creativity has become an important tenet of the literature on economic growth (for example, Florida, 2002; Boschma and Fritsch, 2009; Lee, 2014; Klein and Tremblay, Chapter 27, this volume). Two definitions of ‘creativity’ have been particularly important: the ‘creative class’, commonly defined according to the work of Richard Florida, and; the creative industries, often defined as a sub-set of industries based on intellectual property or new content production (Comunian et al., Chapter 11, this volume). Policy measures focused on creativity can be divided into two categories (Trip and Romein, 2014). The ‘production milieu’ approach focuses on the economic role of creative industries in terms of employment or productivity growth. In contrast, the ‘consumption milieu’ approach is more focused on attracting creative people by developing an attractive urban environment with the amenities these groups apparently need, an approach more closely associated with theories of the ‘creative class’. While many critiques of policies in this area focus on the latter, Trip and Romein (2014) argue that most policies are actually in the former category.

Strategies in the production milieu category have raised concerns about inclusivity and their role in local economies. Strategies focused on the creative industries are often viewed as potential drivers of economic growth in inner cities and lagging regions (Cooke and De Propris, 2011; Lee, 2014). In the United Kingdom, for example, throughout the 2000s, the government attempted to use creative industries to serve these dual purposes of both growth and social inclusion, yet critics have suggested that this overlap with social policy was not always successful as the ‘creative industries’ have not been open to incomers from all backgrounds, but instead are often focused on the already privileged groups in the economy (Oakley, 2006). Empirical evidence has highlighted the potential of fast growing creative industries – often in relatively mundane segments of the information technology (IT) sector – to crowd out existing firms in the areas in which they locate (Lee, 2014).

The dominant theoretical concept in this area has been Florida’s ‘creative class’ – a coalition of workers in advanced cognitive industries, including both those in Bohemian occupations in the arts and more mundane workers in law or finance. Florida’s theory has raised significant concerns amongst academics, both for its theoretical content and for the policy measures it has inspired. One common line of critique is the relationship between the creative class and inequality (Florida, 2014). At a basic level, research by
Florida himself has shown that US cities with higher shares of the ‘creative class’ also tend to be more unequal (Florida and Mellander, 2016). In a similar manner to that suggested in theories of the impact of technological change, concurrent with growth in the creative class is an emerging service class of workers associated with their consumerist habits (Donegan and Lowe, 2008): Florida’s creative workers require baristas to serve their coffee.

A second critique of the creative class approach is that in focusing attention on the need to attract creative workers, public priorities may be skewed to favour these – often already privileged – groups (Bayliss, 2007). Efforts to attract new, economically exciting creative workers have some significant consequences for less creative existing residents. Rather than focus on the welfare of existing residents, who may benefit from such mundane policies as improved education, transport or access to employment, the creative class approach suggests that for urban economies to thrive requires refocusing attention on a relatively small core of workers (Oakley, 2006). Often, this means focusing on the ‘experience’ economy and the availability of art galleries and other forms of cultural consumption (Bayliss, 2007).

25.3.1 Gentrification and Displacement

A third line of critique relates to the impact of creative industries and creative workers on gentrification and on the displacement of other groups. Approaches to develop creative quarters can have the side effect of displacing the original ‘creative’ residents or firms. In one example, Champion (2010) documents the processes through which waves of incomers have reshaped the Northern Quarter district in Manchester, England. This happens through a series of related waves of redevelopment (Cameron and Coaffee, 2005). First, artists move into an area taking over undervalued spaces. These are followed by middle class residents attracted to the neighbourhood, harbingers of a third wave of public and private capital under the guise of ‘regeneration’ of the area. In this way, there is a process of gentrification of previously creative areas, resulting in higher prices and displacement of some existing residents (although some, of course, will gain from higher property values). So, while the creative class can be seen as a vector for rejuvenating inner cities, there can be consequences in terms of the displacement of existing groups. Projects designed to improve wellbeing, in particular through arts projects, can have the side effect of reducing housing affordability for the groups they aim to help (Atkinson and Easthope, 2009).

Processes of inequality will be apparent even within creative industries or creative groups in the labour market. Creativity does not always result in affluence, and many creative workers work in precarious and low paid employment. The view of ‘creativity’ as synonymous with growth and affluence stands in contrast to the evidence about the often low and erratic earnings of workers in these sectors (Comunian et al., 2010). There can be erratic returns to labour in some creative occupations, potentially based on a supply of labour willing to accept low returns in the short term on the expectation of a larger payoff: but it is clear that while the ‘creative class’ as a whole out-earns most other types of occupation, the distribution of these earnings is skewed within the group.
25.4 INEQUALITY, POVERTY AND THE LABOUR MARKET

25.4.1 Are Innovative Cities more Unequal?

There have long been concerns about the tendency for certain elite groups to cluster in large cities, so extending the tail of the earnings distribution (Scott, 2009). Innovative cities may help create the conditions for such extreme wealth and so drive inequality. Cities such as London have seen significant growth in earnings inequality, the main cause being a single sector – financial services (Stewart, 2011). Silicon Valley, the most common case study of innovation-driven growth, has seen similarly conspicuous divides between well-paid workers in innovative sectors and those in other sectors. This led Florida to argue that: ‘Not only is Silicon Valley the home of great economic wealth; it’s also one of the most innovative and creative regions in the world. If ever a rising tide of prosperity were going to lift all boats, you would expect it to happen here. Yet it doesn’t. Instead the opposite occurs’ (Florida, 2005, p. 186).

There is a growing literature on the relationship between innovation and inequality at a city or regional level. One of the earliest studies was Donegan and Lowe (2008), who investigate the determinants of inequality in US cities using a cross-sectional regression model. Their measure of innovation is a ‘tech-pole’ index, which they find is positively related to city-level inequality. In a comparative study of European regions and US cities, Lee and Rodríguez-Pose (2013) find strong evidence that innovation increases inequality in Europe, but not in the United States. However, their study is based on survey data for relatively short time periods. Similarly, Perugini and Martino (2008) use Luxembourg Income Survey data to consider the link between R&D and inequality in European regions and find some evidence of a positive relationship.

These studies tend to be based on surveys, which make them vulnerable to measurement error. The most robust study yet in this field is by Breau et al. (2014) who consider the relationship between inequality and innovation in Canadian cities, using Census data between 1996 and 2006, while considering potential endogeneity problems using instrumental variables. They find a positive, statistically significant and robust relationship between innovation and inequality. They also suggest that knowledge-intensive industries are associated with greater inequality, a finding supported by Lee’s (2011) analysis of European data.

Other research has considered the benefits of clustering economic activity in particular areas. Fowler and Kleit (2014) argue the concept of economic clusters – groups of geographically proximate, interlinked and often innovative firms – has been important to researchers in the geography of innovation. Yet, while studies consider the relationship between these clusters and aggregate growth, few studies consider their relationship with poverty. Their evidence suggests that the presence of clusters in the United States is associated with lower poverty rates.

Does inequality at a local level like this matter? To some extent it is the price of success, as inequality will inevitably be higher in cities with more high-wage workers than those without, in the absence of city-level wage setting or tax institutions. It might also be the case that employment rates are higher in these cities, with low-skilled workers more likely to be in employment in these cities than others. Lee et al. (2014) report that employment rates for low-skilled workers are higher in the more unequal cities of the
United Kingdom, with a one point increase in the Gini coefficient associated with a roughly 1 per cent extra chance of employment for low-skilled workers. Yet, the gains for low-skilled workers in terms of both increased employment rates and wages must be set against the increased cost of living faced by workers in these cities. Little research has considered the potential increases in cost of housing and other raised prices in cities that are apparently economically successful.

The relationship between innovation and inequality may not run in a single direction: inequality itself may have an impact on innovation and future growth (Partridge and Weinstein, 2013). Rewards for innovation are seen by some as necessary to ensure there are incentives to innovate and create growth, yet these rewards may drive inequality. Higher returns to education encourage investment in skills and education, but are also associated with higher inequality (Partridge and Weinstein, 2013).

25.4.2 Revisiting the Benefits of Inequality

There is a clear tension faced by cities between economic growth, driven by innovation and creativity, and the potentially unequal consequences. Yet, even this is not quite as simple as it seems – innovation may have a cost (in the form of inequality) but at the same time may provide benefits for the local economy, with employment raising incomes and removing workers from poverty. As the country often seen as closest to the technological frontier, and one with highly geographically concentrated patterns of innovation, the United States may be seen as an exemplar of these trends (Crescenzi et al., 2007).

The relationship between innovation and two outcomes – inequality and poverty – in US cities (MSAs) are outlined in Figures 25.1 and 25.2. Innovation is simply the natural log of the number of patents per capita. Given the skewed distribution of innovation it is not surprising that there are some significant outliers – San Jose, the MSA which is at the heart of Silicon Valley – has an incredibly high rate of patenting.

Inequality is given as the Gini coefficient of the gross wage income of full-time workers (those working more than 34 hours a week), where a higher figure indicates greater inequality. It does not include income from other sources. The results suggest that innovation increases inequality: taken as a simple linear relationship, and without including any controls, a 1 per cent increase in the number of patents per capita is associated with a 0.09 point increase in the Gini coefficient (compared to a mean of 0.39). But this is driven largely by a small number of relatively unequal cities, such as the clear outlier of San Jose (the MSA that includes Silicon Valley).

Yet, evidence from the same data suggests that there may be some benefit from innovation to disadvantaged groups. Figure 25.2 gives the relationship between innovation and household poverty rates (defined using a national income standard, and so not considering cost of living, and adjusted to take into account the needs of different household types). As before, the relationship is statistically significant but in this case it is positive: without controls, a 1 per cent increase in the number of patents per capita is associated with a 0.4 percentage point reduction in the share of households in poverty. There are a number of caveats to this view, of course: they use a national figure for poverty calculations that does not reflect changes in local cost of living, and they do not control for the characteristics of the workforce (there may simply be fewer workers in the groups normally at risk of poverty). Note that while the slopes of the regression lines included in
both scatter plots differ according to whether these outliers are included, with or without them there is a statistically significant relationship. Overall innovation is associated with greater inequality, but may reduce poverty.

### 25.4.3 Alternatives to Innovation

If local policymakers are concerned about the consequences of innovation, what other options are there? Innovation is highly spatially uneven, and as well as considering the situation in the most innovative, creative and affluent cities and regions it is also instructive to consider outcomes for different groups in areas that are less successful on this front. The first consideration is that if innovation is associated with local growth – as a wide body of evidence suggests – one consequence of a lack of innovation may be growing disparities between places, rather than within places (Harris, 2011). Without innovation- or creativity-led growth cities risk being left behind by national-level growth processes.

In some extreme cases, urban economies that do not adapt to change become the victims of innovation. Technological change can make certain industries less relevant. This effect will not be spatially neutral, but focused in particular cities and regions that either specialize in these activities or have characteristics that technological change can address: a process of place-biased technological change. There are a number of potential examples of this phenomenon. In the United Kingdom, the industrial revolution...
favoured urban locations in the North of the country because of their proximity to both cheap energy resources (coal) and their relatively wet climate, which made it easier to spin wool. Yet, technological change reduced the impact of both these advantages and meant proximity to the motorway network gained in relative importance (Leunig and Swaffield, 2008). Polèse and Shearmur (2006), for example, argue that the rise of recycled paper has made it less important for paper mills to be located in heavily forested regions; they can obtain their inputs from elsewhere. The result has been economic and population decline in mill towns in Canadian peripheral regions.

At the same time, certain regions will also gain from the indirect effect of innovation, as technology interacts with institutional characteristics. While controversial, one example here is population growth in the sun-belt of the United States. New technology in the form of air-conditioning, alongside a new road network, is said to have allowed the growth of these areas (Storper, 2013). At the same time, there were fewer restrictions in housing supply than older cities in the North of the country, and so both institutions and technological change combined to favour some places over others. While this approach has been challenged (see Storper, 2013 for an overview), it does suggest that technological change will have an impact that is biased over space.

Second, in addition to growing regional disparities, lack of economic growth in a particular city or region will have its own consequences. Partridge and Weinstein (2013) suggest that there can be a trade-off between job creation and inequality. Cities with weak economies tend to have higher unemployment rates, lower wages and difficulties retaining residents. While residents of these cities may be perfectly happy, and may live

**Figure 25.2  Poverty and innovation in US MSAs, 2011**

Note: PATPER = natural log of patents per capita. Pov_2 = household poverty rate. 295 observations.
in less unequal places, they may suffer welfare losses based on the unfulfilled economic potential.

25.5 CONCLUSIONS: COPING WITH THE CONSEQUENCES?

There have been many studies on the impact of innovation on local growth, yet relatively few studies have considered the other consequences of innovation. But innovation will have significant impacts on the labour market and in doing so will have different impacts on different groups. Innovation-led growth is understood to be driven by high-income earners, and so the price of innovation may be inequality. And newcomers drawn to cities because of their creative ‘buzz’ or ready access to amenities will impact existing residents.

Yet, it is hard to consider how any local economy can experience significant growth without innovation or creativity. A brief consideration of the alternatives for a local economy – lacklustre economic growth, economic and, potentially, population decline – suggest that there are few alternatives to innovation-led growth. Inequality may also be associated with higher employment rates and wages amongst normally low-income groups – an advantage eroded by higher costs. So the costs of innovation need to be set against its significant benefits, and the consequences of not innovating also need to be considered. A sensible policy framework would manage these issues rather than take them as reasons to prevent innovation. Options for doing this might include ensuring growth does not translate into rising costs, particularly in the housing market, and ensuring that workers are adaptable to economic change, so those who are displaced or lose out because of innovation are able to return to the labour market.

However, there has been relatively little research on the consequences of innovation and on the geography of these consequences. This chapter highlights a number of potential areas for future research. The first gap relates to the actual living standards of those in the most innovative cities. While there is evidence on the wages of those working in non-innovative, non-tradeable sectors in these cities, studies have yet to consider the influence of changing prices on the real income of individuals. Second, and related to this, research needs to consider the erratic dimensions of earnings in innovative sectors, in particular, in the creative industries. Finally, there is little evidence on the relationship between inequality and growth. While studies focus on the impact of innovation on inequality, there may be reasons to view the reverse relationship as also existing. Inequality might reduce incentives to innovate, for example, and encourage the affluent to engage in protective, rent-seeking behaviour rather than engage in risky innovative activities that, if they don’t succeed, will see them drop down the income spectrum.

NOTE

1. The source of the data is the IPUMS-USA database available from the University of Minnesota. Patent data have been aggregated from county level to the MSA levels included in the IPUMS-USA database.
REFERENCES


Growth with inequality?


Why local development and local innovation are not the same thing: the uneven geographic distribution of innovation-related development

Richard Shearmur

26.1 INTRODUCTION

In much of the innovation literature, and particularly in policy documents, there is an assumption that local development – that is, the creation of jobs and income in a sub-national spatial unit, often a town or a county – is directly connected to the innovative capacity of local enterprises. For instance, whilst the Organisation for Economic Co-operation and Development (OECD) distinguishes between regional policy and innovation policy, it calls for their increased integration since ‘these policies have an impact on the performance of regions’ (OECD, 2014, p. 1). In harmony with this top-down view, numerous cities and localities are emphasizing innovation (and creativity – seen as a precursor to firm-level innovation) as a key component of their local (bottom-up) development strategies. Montreal, for instance, has an economic action plan that focuses upon innovation because ‘Major cities have to rely on knowledge and innovation to ensure their growth and prosperity’ (Montreal, 2010, p. 18). Remote regions, such as Gaspésie, are implementing policies – such as INNOVARE (Gaspésie, 2015) – to support innovation in their small and medium-sized enterprises (SMEs). Whether the connection between innovation and economic development is explicitly stated, or merely assumed, there is strong adherence to the idea that local development passes through local entrepreneurial innovation.

In this chapter I examine this belief. The examination proceeds as follows. I first suggest that the vast majority of research on the connection between entrepreneurial innovation and regions has focused on understanding the way in which different geographic contexts and locations are more or less conducive to firm-level innovation. This work has recently expanded into attempts to understand how firms reach out, along virtual and physical networks, to tap into resources in more distant locations. Given that this work does not address the impact that innovation has on localities, I then propose an explanation for why it is assumed that local innovation and local growth are connected: whilst I do not wish to suggest that sustainable (in the sense of long-term) local development is possible without some degree of local innovation, I argue that it is possible – and indeed likely – that in many circumstances (that is, in most smaller cities and regions) local firms can be innovative without engendering any local growth or development. I shall refer to some exploratory evidence on the topic, but also to some examples that call into question the connection between local innovation and local growth. This evidence is by no means conclusive: the main aim of this chapter is to show that it is legitimate to ask whether local innovation is connected to local development. Once this question is legitimated, a new area of study opens up, that is, exploring the geography of innovation’s impacts, an
exploration that is of interest to researchers and policy-makers concerned with regional development, but that is of less interest to those whose main focus is on system-wide innovation.

26.2 FROM LOCALITY TO INNOVATION: A ONE-WAY RELATIONSHIP?

The thrust of research on innovation and regions has been to explore how localities and regions generate innovation: local development consequences are either assumed to exist, or are simply not of primary interest. As McCann and Ortega-Argilés (2013) outline in their review of European innovation policy, the policy motivation behind geographic innovation studies has often been the identification of optimal spatial configurations of innovative activities in view of maximizing national (or European) innovation performance. Thus, for instance, Camagni and Capello’s (2013) description of Europe’s smart innovation policy illustrates how innovation, not regional development, is at the centre of the European Unions’ concerns: the authors argue that different types of region are more or less conducive to sustaining different types of innovation process, but there is no discussion of whether these regions will benefit from the innovation that occurs locally. The thrust of their argument revolves around how policies should be embedded in local realities and should adapt to them: the policy objective remains European-wide innovation, not local development.

Notwithstanding this national (or European) focus on system-wide innovation and world-firsts, innovation policies are implemented by local decision-makers on the assumption that local innovation is connected with local growth, an assumption implicitly endorsed by, but not usually explicitly expressed, by national decision-makers. This causal relationship finds support – but relatively sparse evidence – in the literature on regions and innovation. Indeed, the idea that local innovation leads to local development, and are maybe even synonymous, can be traced back to the seminal work of Piore and Sabel (1984). They were amongst the first to have observed that local economies most successfully pulling through the recession of the early 1980s were those constituted of dense networks of related SMEs, exchanging information and collaborating in view of developing new products and processes in response to external demand. These observations were repeated in other contexts (Benko and Lipietz, 1992; Maillat et al., 1992) and were formalized into the concept of ‘innovative milieux’, that is, localities in which firms are innovative thanks to the circulation of labour and ideas, and to the division of labour between firms in related sectors. During the late 1980s and 1990s a number of other distinct but related concepts emerged. For instance, Lundvall (1992) introduced the idea of national innovation systems, that is, interconnected national institutions (education systems, taxation structure, research and development traditions) and economic culture (openness to ideas, collaboration, entrepreneurship) conducive to the emergence and implementation of new ideas. This was transposed to the regional level (Cooke et al., 2004), not without some qualifications from Lundvall (2007) who argues that many of the processes and institutions he describes are not regionally circumscribed. Florida (1995) suggests that certain regions possess the institutions (universities, high-order services) and human capital to identify and use knowledge and information in pursuit of innovation. These
Handbook on the geographies of innovation

concepts have in common that they associate the internal dynamics of regions with the propensity of local firms to innovate (Moulaert and Sekia, 2003; Frenken, 2007). They also have in common the implicit assumption that these local innovation processes lead to local development.

This work on innovation and regional dynamics is strongly connected with contemporaneous work on the globalization of production chains and the dis-embedding of production processes. Indeed, researchers approaching the question from a neo-Marxist perspective (such as Massey, 1985; Storper and Walker, 1989) saw local and regional dynamics as a way of countering the power of large corporations to play regions off against one another. As global capital increasingly divested from particular regions (for instance, if labour was deemed too demanding, if costs were too high or, sometimes, for reasons of internal strategy unconnected with local circumstances), embedded local economic activity (such as networks of small and medium-sized companies, a knowledgeable local workforce, certain local institutions) was seen as a way for communities and localities to resist the economic consequences of global trends.

In this context, innovation became a key vector through which it was thought that localities could anchor economic activity: if innovation dynamics are locally embedded, then they provide some means for communities to offset the destructive effects of mobile capital. Paradoxically, researchers and policy-makers approaching the question from a more neoliberal perspective also saw merit in the idea that regional innovation and development processes are endogenous: this provides justification for the dismantling of regional redistributive policies (Rowlands, 1994), and also promotes competition between regions and localities (Lever and Turok, 1999).

Research investigating the connection between local processes and innovation has tended to proceed by way of detailed case studies: its focus has been on unravelling the ways in which innovation is enhanced by endogenous dynamics. This research has been criticized, however, since it has tended to put forward general propositions that have only been verified by way of case studies (Markusen, 1999). Furthermore, the idea that local processes alone can lead to local innovation has increasingly been questioned. Bathelt et al. (2004), for instance, argue that ‘buzzing’ localities (usually cities within which innovation dynamics occur, but see Gibson, 2011) are interconnected, and that exchanges between them are just as important as local dynamics. The French proximity school (Boschma, 2005; Carrincazeaux and Coris, 2011) has argued that physical co-location is not always necessary for innovation dynamics involving learning and knowledge exchange: temporary travel, meetings at fairs and conferences or short periods of co-work create social, cognitive and other proximities that are just as relevant as geographic proximity in enhancing collaboration and exchanges necessary for innovative projects to proceed. Shearmur (2011) and Doloreux and Shearmur (2012) have shown that innovation in Quebec, whether in manufacturing or the service sector, is not strongly associated with the characteristics of the locality within which establishments are located, and McCann (2007) has made a similar point theoretically.

None of this research, however, focuses upon whether local innovation leads to local economic development. This can possibly be explained by three things. First, endogenous growth theory (to which I shall turn below), which establishes that private sector innovation leads to economic growth, is assumed to also establish that local innovation leads to local economic development. The ecological fallacy embedded in this change of scale is
often overlooked. Second, the idea that innovation is associated with local development and growth emerged from observing that certain localities weathered the 1980s recession better than others: this historically contingent observation has been generalized. Third, the political overtones of the arguments put forward – and maybe the fetishization of innovation (Harvey, 2010, p. 91) – may have discouraged detailed analysis of the assumption that local innovation dynamics lead to local economic development, and downplayed the complexity of the association between innovation and local growth when it does occur (see Gibson, 2008, who discusses creative industries).

In recent years some researchers have begun to empirically investigate the consequences of innovation on regions. Krätke (2011) and Breau et al. (2014), for instance, demonstrate that innovation and creativity within cities are associated with unequal outcomes amongst the population. Rothwell et al. (2013), looking at US metropolitan areas show that patents – and associated growth – are related only in the largest cities and in those that have certain knowledge transfer institutions. Malecki (2010) emphasizes the difficulty that many regions have in fully participating in, and benefiting from, the knowledge economy. These are geographically related examples of the growing interest in the distributional consequences of innovation-led growth (Piketty, 2013).

A key question concerning the connection between local development and innovation is the following: given the research just outlined, and the paucity of systematic evidence linking local innovation to local growth, why has this idea become so pervasive? One element of the answer has already been addressed: there are numerous case studies that describe instances of local development being propelled by local innovation. Another element of the answer has just been alluded to: that is, the influence of wider economic theories on thinking about regional economies. It is to this that I now turn.

26.3 ENDOGENOUS ECONOMIC GROWTH AND REGIONAL DEVELOPMENT

One of the perplexing questions that motivates this chapter concerns the reason why such an obvious question – does local innovation lead to local growth? – has not yet been fully explored. One possible way of understanding this is to examine the way in which economists have theorized growth, and to bear in mind that the ascendancy (or not) of particular theories is often closely associated with wider ideological assumptions. Private sector innovation, because it drives consumption and global growth (whilst occasionally delivering large-scale social benefits, but also large-scale social disasters such as DDT, thalidomide and the 2008 financial crisis), is currently considered an end in itself. Thus, an economic theory that legitimizes this belief, however well founded it may or may not be, will more easily gain ascendancy than one that questions it. This is as true in economics as it is in geography and regional studies, particularly in segments of the discipline that are policy oriented. These considerations lead me to examine endogenous growth theory, a theory that has lent indirect support and legitimacy to the idea that local innovation leads to local development.

Indeed, there is no elegant self-contained theory of regional development. Notwithstanding attempts by regional scientists, such as Isard (1956), to build a general framework, our understanding of the development of local and regional economies
remains piecemeal: a variety of models and theories allow us to understand particular aspects of local development, but an overarching theory eludes us. The reason for this probably rests on fundamental ontological differences between economics – which believes in nomothetic (law-like) theories that govern the behaviour of economic actors – and geography – a more idiographic discipline that takes note of particularities. However, general laws and models are intellectually fascinating, and, for many, are the hallmarks of true scientific thinking (Mirowski, 1989). Thus, recent advances in theories of economic growth have strongly influenced the way in which local development (and its connection with local innovation) has been understood.

Until the 1950s long-term economic growth was understood to rest principally upon exogenous factors such as labour (hours worked, population), balance of trade surpluses and the discovery of new resources, colonial or otherwise. Historians and historically minded economists (Lewis, 1955; Freeman and Louça, 2001) pointed out that culture, technology and institutions played a role, but this had only tangentially been incorporated into economic theory. This began to change in the 1950s when Solow (1956) – benefiting from Kuznets’s recent calculation of US gross domestic product (GDP) figures (Piketty, 2013) – showed that GDP growth could only be understood if a technological component was introduced. In other words, GDP growth, whilst dependent on exogenous inputs, also rests upon the quality of these inputs. As technology – and human capital (Becker, 1962) – improve, so GDP grows. These ideas were expanded upon during the 1970s and 1980s (Lucas, 1988; Romer, 1989) to the extent that, in the face of declines in western population growth, trade surpluses and rate of discovery of new resources, economic growth was increasingly understood as endogenous. It is now commonly held that growth rests upon innovation, both technological and also in the realm of organization and procedures (OECD, 2005; Frenken, 2007), which are internal to the economic system.

These theories have proved influential, and have impacted the orientation of national economic development policies (for example, McCann and Ortega-Argilès, 2013; Industry Canada, 2014). Empirical evidence indeed suggests that nations that house more innovative industries, and increasingly those whose nationals detain intellectual property rights over innovation, grow faster than others (Moser, 2013). Furthermore, the same applies to large cities: cities with more innovative industries and establishments seem to grow faster than others (Bettencourt et al., 2007). However, these results do not demonstrate that endogenous growth theories are relevant to regional development (Martin and Sunley, 1998). Nations and large cities have in common their size, and their ability – at least during the 1980s and 1990s – to internalize some of the processes of creative destruction. Indeed, innovation implies the decline of older less competitive industries and firms, and the growth of newer more competitive ones (Malecki, 1997). It is only if decline and growth occur in the same region that the benefits of innovation will devolve to the region where it occurs: if innovation leads to decline in some places and growth in others, ‘[it] can become destructive and ruinous . . . [and] . . . destabilizing of social relations’ (Harvey, 2010, pp. 92–3), in particular, within the regions where innovation means job and income losses.

Since the late 1990s other factors have emerged that further weaken the theoretical connection between local innovation and local economic development. Ease of travel (Torre, 2008; Bathelt, 2011) and communication (Moriset and Malecki, 2009; Shearmur and
Doloreux, 2015a) mean that actors in one location increasingly contribute to innovation in firms located elsewhere. The globalization of value chains (Dicken, 2011) means that financial and other returns to innovation do not necessarily accrue in the place where innovation occurs – if, indeed, it is possible, in such value chains, to associate innovation with any particular location (Shearmur, 2012, 2015). These ideas are related to those put forward in the 1980s by Massey (1985) and Storper and Walker (1989) – referred to above – who point out that regional growth and decline are more closely associated with corporate strategy – for example, plant closures, geographic arbitrage – than with processes or dynamics intrinsic to the region. The arguments made by Massey (1985) and others have (re)gained in saliency as new communications technologies have eased coordination. Furthermore, their arguments no longer only apply to large corporations: SMEs can now also coordinate their production, markets and supply chains over longer distances.

In a context of neoliberalization, a theory that establishes that regions are responsible for their own economic fates (thereby obfuscating the role played by corporate strategy, finance and other external forces) will gain in popularity – at least amongst policy-makers and in much policy-related research. Endogenous growth theory, when (mis)applied to regions, is such a theory, and its empirical validity at the regional scale has not been closely scrutinized. Thus, notwithstanding the widespread belief that local innovation leads to local growth and the many local policies that implicitly act upon this belief, it is legitimate to ask whether innovation in local firms leads to local economic development. This question arises in particular for smaller non-metropolitan regions: larger cities have sufficient human and infrastructural resources to internalize some of the processes described. There is no reason to assume that smaller cities and regions are able to capture the benefits of local innovation.

26.4 THE MEASURE OF INNOVATION: A FURTHER SOURCE OF GEOGRAPHIC CONFUSION

In order to establish systematically – rather than anecdotally – whether or not local innovation is connected with local development, a clear definition of innovation is necessary, one that can be operationalized in an unbiased manner across a wide variety of localities. Only if such a measure exists will it be possible to begin addressing the assumption that local innovation leads to local development.

The definition of innovation implicit in this chapter is that adopted by the OECD (2005) Oslo Manual. The fact that the definition has so far remained implicit is itself revelatory of a problem in work on the geography of innovation. The term ‘innovation’ can mean many things, and can be defined in a variety of ways: the choices made carry the possibility of geographic bias, which can then bias our understanding of the connection between local development and local innovation.

The OECD (2005) definition is limited to firm-level innovation, and consists in the introduction of a new or improved product, process, management approach or marketing strategy. Innovation can be new to the firm – that is, essentially imitative (Godin, 2008) – or new to the firm’s market or to the world. One of the sources of confusion in the literature on the geography of innovation is the multitude of definitions, indicators and levels at which innovation can be conceived (Evans, 2009). This chapter is anchored
to the firm or establishment level, and only considers social and policy innovations in so far as they have an impact upon firm-level innovation (that is, in so far as they are part of a wider institutional context).

At the firm level, there are also a variety of approaches to defining innovation. One of the most widespread is to equate innovation with patents (Moser, 2013). This is a powerful way of studying innovation within particular industries – those that protect their innovations with patents. However, patents are a poor indicator of the geography of innovation since they conceal a number of biases. First, patents do not always lead to innovation (that is, to the implementation or marketing of a new product or process) (Jaffe and Lerner, 2007; Heller, 2008). Larger establishments often patent defensively. Since larger establishments tend to be over-represented in cities, this introduces a spatial bias. Second, smaller establishments have a higher probability of using secrecy to protect their innovation (Brouwer and Kleinknecht, 1999), furthering the urban bias of patent measures. Third, patent protection is only viable for new products or technologies that can easily be protected: most process innovations, and almost all management and marketing innovations remain unpatented. Given the propensity of process innovators to locate outside large cities (Duranton and Puga, 2001), this further biases patents towards large cities. Finally, patents are usually silent about innovation that occurs outside a few manufacturing goods or high-technology sectors, that is, they tell us little about innovation in most of the economy.

Another way of measuring innovation is by way of surveys, such as the Innovation Survey run by Statistics Canada and the European Community Innovation Survey (Shearmur, 2013). These ask firms or establishments whether they have introduced an innovation (as defined by the Oslo Manual), and enquire into aspects of the firm or establishment’s innovation process. The surveys are usually not very fine-grained geographically, but do enable the comparison of innovation between large cities and regions. Whilst they can be criticized for not distinguishing between major world-first innovation and incremental innovation, this critique highlights the different motivations for studying innovation discussed in the first section of this chapter. At the national level it is major innovations – those that have a system-wide impact – that are of interest (so surveys are of limited use). However, from the perspective of regional development, it is the capacity of firms to keep up and adapt that is of interest: this is reflected by minor innovations as well as by world-firsts (so surveys are valuable).

Whichever measure of innovation is chosen, a key distinction must be made between innovation measured at the firm level, and innovation measured at the establishment level. Single-establishment firms and multi-establishment firms (as surveyed, for instance, in Canada’s 2005 Innovation Survey) have precise geographic coordinates. However, innovation in multi-establishment firms, if surveyed at the firm level, cannot easily be located. Regarding patents, it is possible to identify the location of the organization that deposits the patent (usually the firm), and the residential address of the researchers involved in developing the patent. The question of ‘where’ the innovation is introduced is problematic, since (a) we are not certain that the patent leads to an innovation, and (b) assuming it does, where the establishment that introduces the innovation is located: the addresses of the inventors provide some indication of where the innovation emanates from (Acs et al., 2002), not of where it will be developed, produced or implemented.

Another question of measurement – but maybe a less severe one – arises when it
comes to assessing local development. A common metric is local GDP – the idea being that innovation in local firms should increase the localities’ overall productivity. It is, however, notoriously difficult to accurately measure GDP at the sub-national level: national accounts are national, not local, so a wide variety of assumptions and approximations are required to arrive at local estimates (Lemelin and Mainguy, 2009). Even if local GDP could be accurately measured, it tells us little about the well-being of the local population, since much of the wealth generated locally could be accumulated elsewhere.

Thus, more direct measures of population well-being are preferable if the question of interest is local development (as opposed to system-wide productivity): local incomes and local employment are better, if imperfect, measures of local development. They are preferable to local GDP because they can generally be measured directly by way of the census or earnings data from tax records, and are tied to local outcomes: a community with rising personal incomes, or in which employment is rising, can be said to be developing to the extent that the population’s economic well-being is improving.

These questions of measurement are critical: to establish whether local innovation is connected in a systematic way to local development, the way in which each of these terms – innovation and development – is conceptualized and measured is of central importance, and is often overlooked.

26.5 IS THERE ANY EVIDENCE THAT LOCAL INNOVATION IS NOT (NECESSARILY) CONNECTED WITH LOCAL DEVELOPMENT?

Whilst there is scant systematic evidence to establish that local innovation is connected to local development, there is, likewise, scant evidence to suggest that it isn’t: this relationship, which is central to much current policy thinking on local and regional development, has been assumed rather than demonstrated, as argued above.

The arguments raised in this chapter do rest, however, on a variety of observations and empirical research conducted by myself – often in collaboration with David Doloreux – in the province of Quebec.

Two key observations drive my dissatisfaction with the assumption that local innovation and local development are connected. The first observation is that there are many regions in Quebec – particularly the less populated and/or remoter regions of the province – that have been suffering from long-term population (and employment) stagnation and decline (Polèse and Shearmur, 2006; Shearmur and Polèse, 2007). The second observation is that, systematically, surveys show that establishments – whether manufacturing (Shearmur, 2011; Shearmur and Doloreux, 2015a) or KIBS (Knowledge Intensive Business Services, Shearmur and Doloreux, 2009) – are just as likely to innovate in Quebec’s remote regions as they are in its more central and metropolitan regions. Four different surveys have revealed essentially the same result. Faced with the systematic nature of these two sets of results, it is difficult to accept without question the idea that firm-level innovation is connected to regional development.

In 2011 an attempt was made to investigate the question more directly (Shearmur and Bonnet, 2011). Using the REGPAT database, 203 Canadian urban areas (down to 10,000 people) were classified according to the ‘inventiveness’ of their local population:
this inventiveness was measured by the per capita propensity to record a patent applica-
tion in the REGPAT database (measured at the place of residence of the inventors).

The results reveal two things. First, notwithstanding a prima facie positive relationship
between employment growth and inventiveness, this is entirely attributable to industrial
structure: once industrial structure is entered, the connection between inventiveness and
employment growth disappears. The result is similar when wage growth is analysed.

Second, the connection between local inventiveness and employment growth is posi-
tive (and resists controls) for manufacturing employment: this suggests that in the sector
where most patenting activity occurs, inventiveness (measured by patents) is indeed
connected to employment growth. However, another key result emerges: inventiveness is
negatively associated with employment growth in professional high-order services (such
as marketing, law and accounting).

These results are suggestive of a process that requires more exploration: they suggest
that local inventiveness (as measured by patents) may drive local employment in the par-
ticular sectors that are inventive, but may also drive employment growth in other locations
as specialized services are called upon to manage the marketing, legal and accounting
challenges that inventiveness (and associated growth and management changes) entails.
Local inventiveness may lead manufacturers in small towns (which dominate the study)
to turn away from local high-order service providers towards better connected and more
experienced providers in larger cities. This is corroborated by recent results on innovation
and service use that show that the more a high-order service is connected with innova-
tion, the more likely it is to be sourced in a metropolitan area, whatever the location of
the innovator (Shearmur and Doloreux, 2015b).

Another process that can contribute to the disconnect between local innovation and
local development revolves around specialization. Many smaller regions and towns are,
necessarily, specialized: diversification is simply impractical in many small towns in
the 10,000–50,000 population range since local industries need to attain a critical mass
for economies of scale and specialization to take effect. It is only in larger cities and
metropolitan areas that industries can attain this critical mass in conjunction with the
city being diversified (that is, harbouring a large number of industries that have each
reached a critical mass) (Shearmur and Polèse, 2005). Thus, in specialized small and
medium-sized towns, process innovation in the local industry can lead to job loss as more
efficient production processes are implemented: it is only if markets are growing faster
than productivity increases that this type of innovation may be job neutral (or may lead
to employment increases). Increased efficiency of the local industry will contribute to
global growth, and, in theory, resources freed-up by these innovations will be put to use
elsewhere in a process of creative destruction. In practice, though, the growth impact of
this efficiency-related innovation is unlikely to be felt locally – it will be diffused amongst
shareholders, clients and other stakeholders, few of which are local. It is only the costs of
efficiency innovation – in terms of job and income losses – that are concentrated locally.
An example of this is the city of Saguenay, which, despite its size of about 150,000, has
been suffering from job and population losses even as its major employer, the aluminum
smelter Alcan, has been increasing production and productivity.

These considerations have led me to consider a way of thinking about the geography
of innovation that explicitly disconnects, at the firm level, the innovation stage (that is,
the development, implementation and first marketing of a product or process) from the
Why local development and local innovation are not the same thing

Local development

No local development

Growth and diffusion stage (Figure 26.1) (Shearmur, 2015; Shearmur and Doloreux, 2016). I suggest, in keeping with the Quebec survey results, that innovation can occur wherever there are entrepreneurs and establishments. In remote areas innovation may be more technological in nature, relying on the marriage of local knowledge with widely available scientific and technological information (obtained either digitally or during temporary face-to-face meetings). Once an innovation is introduced and locally validated, the

Note: Innovation in local firms does not always lead to local development, understood principally as job growth: without jobs, whatever the local GDP, communities disappear. The flow chart summarizes the argument in this chapter. The argument rests upon the premise, increasingly verified by empirical analysts who have explored firm-level innovation in smaller cities and remote areas, that firms in these areas have a propensity to innovate that is similar to that of firms in urban locations.

Figure 26.1 Firm-level innovation and local development
innovative firm has two choices: either it stabilizes, and does not fully exploit the innovation, or it needs to find resources (finance, employees, real-estate, consultants) to help it grow and exploit the innovation on a wider stage. It is at this point that the firm may call upon city-based resources or, quite often, will open a marketing or production subsidiary in proximity to a large city. It may also be bought-up and relocated or closed (Chien, 2014).

Conceptually disconnecting firm-level innovation from firm-level development and growth allows for local innovation and local growth to be similarly disconnected. It provides a framework for asking two separate questions.

1. Does innovation occur locally, and, if so, can local factors of innovation be identified? This question has been addressed in the literature, and continues to be of interest since there is increasing evidence that innovation occurs in a wide variety of geographic contexts (for example, Grillitsch and Nilsson, 2015).

2. When local firms innovate, to what extent do localities capture the benefits of innovation? What local factors facilitate the local capture of innovation-related growth (Figure 26.1)?

26.6 CONCLUSION

In this chapter I have briefly set out the reasons why there is no necessary connection between local innovation and local development. Neither theory nor empirical analysis suggests that the impacts of innovation – in particular, its growth-related impacts – will necessarily be felt locally. This does not mean that there do not exist particular cases where local innovation has brought about local development, nor that there do not exist regional factors that may strengthen the relationship between local innovation and local development. It does mean, however, that local innovation is not a sufficient condition for local development to occur.

This argument raises a conundrum, since even if local innovation is not a sufficient condition for local development to occur, it may well be a necessary one. Indeed, even in situations where local innovation is clearly associated with decline (for instance, when it leads to job losses in specialized regions), the alternative to innovation is not the status quo: it is the temporary survival, and eventual demise, of an inefficient local industry as opposed to the survival of a leaner (and innovative) local industry. It is for this reason that the policy implications of this argument – an argument that calls for more detailed empirical exploration – are not that local innovation should be discouraged. Although innovation is not always of great benefit to society (in many cases it drives consumption more than it drives increases in welfare) it is undeniable that, at the firm level, and given current economic paradigms, innovation is a prerequisite for firm (and regional) survival.

The central implication of the argument is that local innovation policy should be considered separately from local development policy. On the one hand, local innovation policy – if it is implemented locally, and not in view of system-wide innovative efficiency – is about ensuring that local firms survive and prosper: however, unless local firms are inextricably tied to the locality, getting them to innovate may have no local development effect, or may even accelerate their departure from the region (Figure 26.1).
Local development policy, on the other hand, is about ensuring that local firms have access to the capacities (in terms of personnel, infrastructure, knowledge, services and so on) necessary for them to grow, develop and market their products and services. The problem is that these capacities tend to be more accessible in large cities and central regions than in smaller remote ones. Thus, large cities and regions have a far greater propensity to internalize processes of creative destruction than do smaller regions: not only can resources freed-up by productivity innovations (or by new products replacing older ones) be more readily reused within larger regions, innovators are more likely to find, within them, the capacities and resources they require to grow.

This does not mean that small regions are destined to decline whether their local firms are innovative or not. It means that local development policies in smaller regions should be turned outwards, focused on facilitating – by means of information, infrastructure and transport policy – the connection between growing local firms and potential employees, service providers and clients outside the region. These connections should work both ways, also facilitating the connection of external demand with local know-how. With the advent of the internet most regions are no longer isolated – at least not from cutting-edge scientific and technological knowledge, even if they remain more distant from market rumours and short-term fashions (Shearmur and Doloreux, 2016). There are thus fewer informational barriers for certain types of innovator – for example, those relying on internal capacity and non-market information (Shearmur, 2015) – to locate there. Local development policy should focus on the challenge – which is a major one – of enabling these more isolated innovators to take off and grow in situ, rather than turning to cities and metropolitan areas when the pressures of firm development and growth arise.

This view of local development is a classic one: it harks back to the idea of local multipliers, and highlights the rapidly growing antagonism between system-wide economic efficiency (that is, growth in global GDP) and the distribution – both social and geographic – of the product of this efficiency (Massey, 1985; Storper and Walker, 1989; Piketty, 2013). The problem for local communities is that they can contribute to overall economic growth – by fostering local innovation – whilst reaping little or no reward. Capital mobility ensures that successful innovators will gravitate towards market centres and/or the most efficient locations to exploit innovation (Massey, 1985): investors, financiers and shareholders will benefit, but the localities that foster innovation may see little or no return.

NOTES

1. Thus, Industry Canada – a federal ministry – has an innovation strategy (Industry Canada, 2014) focused upon promoting the country’s innovative potential: nevertheless, the prime minister’s introduction to the policy document begins with the following sentence: ‘The success of our economy, the prosperity of our communities and the well-being of our families depend on advancing cutting-edge science, technology and innovation in Canada.’ The reference to communities is telling: it is implied, but not directly stated, that all Canadian communities will benefit from innovation. In the policy document itself it is stated that ‘Federal regional development agencies deliver targeted programs at the regional and local levels to enhance innovation, business and community economic development’ (p. 14), here too implying that there will be local benefits to this investment in local innovators.

2. An ecological fallacy occurs when it is assumed that a process occurring at one scale also occurs at another. In this case, it is not because global growth is driven by innovation that local growth is driven by local
innovation: as elaborated below, this is simply because it is quite feasible for growth to occur in some localities and not in others, whereas, at the global scale, such distributional questions are irrelevant.

3. One of which has just been conducted, the results of which are not yet published.

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Why local development and local innovation are not the same thing


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Torre, A., 2008, ‘On the role played by temporary geographical proximity in knowledge transmission’, Regional Studies, 42(6), 869–89.
27. Cultural creation and social innovation as the basis for building a cohesive city*

Juan-Luis Klein and Diane-Gabrielle Tremblay

27.1 INTRODUCTION

The objective of this chapter is to present an overall and critical vision of the main theoretical elements, debates and strategic perspectives that make it possible to establish a link between creation and innovation, on the one hand, and the building of social cohesion in the city, on the other. This objective faces three challenges. The first is that creation and innovation are generally treated independently, with the act of creation often seen as the result of individual action, whereas the act of innovating is associated with a social process, that is, with the broader spread and development of the results of creation (Sternberg, 1999). The second challenge is that the authors who discuss creation and innovation do so without paying attention to the social cohesion issue, and it is this dimension that will be the focal point of our text. This is important because there is a risk of rising inequalities as a consequence of the destructive effects of innovation and thus also, indirectly, of creation (Scott, 2006a). This results mainly in the concentration of power in some geographic areas, which become ‘winning areas’ (Benko and Lipietz, 1992), at the expense of others, which become ‘losing areas’ (Côté et al., 1995) – a worrying perspective for social cohesion. The third challenge is that creation and innovation can take place in all sectors of activity and not only in the artistic, cultural sectors or high-tech sectors (Scott, 2006a). In this text, we limit the topic by posing the question as follows: How can creation and innovation be combined to make the city more cohesive and at the same time contribute to the economic and social development of the whole city, and not only to the development of creative or cultural services and activities for a certain part of the population (the ‘creatives’)?

In order to respond to this question, we divide the chapter into three main sections. The first defines the main concepts and presents the main challenges raised by the literature concerning creation and social cohesion. The second section provides a summary of the main debates on creation and creativity in the city and offers some propositions resulting from our literature review that could generate a creativity-based approach to social cohesion in an urban setting. The third section sets the groundwork for an approach that would allow for the implementation of action based on these propositions.

The issue of creation and of the creatives and their impact on the city and on economic development has already been addressed by several authors (Hall, 2000; Florida, 2002; Markusen and King, 2003; Gertler, 2004; Scott, 2006b; Musterd and Murie, 2010, amongst others). These authors have insisted on creation-based activities and their links with creativity, the creative economy and competitiveness. While considering these contributions, this text is distinguished from preceding work in that it focuses on socially oriented collective actions of creation taking place in civil society and that aim to enhance
quality of life at the neighbourhood level. We suggest that this specific type of creative action should be encouraged and supported in order to build a more cohesive city ‘from below’ (Stöhr, 2003) and emphasize that this calls for a participative and inclusive strategy.

27.2 THE MAIN CONCEPTS AND THE MAIN CHALLENGES: WHAT CREATION FOR WHAT SOCIAL COHESION?

This section will show the urgency to rethink social cohesion in a way that is compatible with a society that is very different from the one referred to by Durkheim at the dawn of Fordism and of the mass consumer society of the golden sixties (Pahl, 1991; Jenson, 1998; Forrest and Kearns, 2001; Novy et al., 2012). At the beginning of the twenty-first century, as a result of globalization, society has become less uniform, more diversified (Scott, 2006a). Actors and citizens are increasingly in search of new identities that reflect their cultural distinctions and simultaneously want to find solutions to the major social problems provoked by structural injustices (Young, 2000). This increasing social and cultural diversity challenges homogeneous public policies and programmes and poses new problems of integration (Sandercock, 2004). In this section, we first discuss the factors that reduce social cohesion as a consequence of some economic trends engendered by globalization, such as mobility of financial capital, work flexibility and state disempowerment, as shown dramatically by the recent financial and economic crisis, and resulting job losses and unemployment, in particular (Novy et al., 2012). We then present different points of view on ways to rebuild social cohesion, taking into account the specific challenges posed by the new social and economic context. The different viewpoints expressed in the literature on creation, social cohesion and innovation are thus considered, leading to our notion of ‘social creation’.

27.2.1 Globalization and Social Cohesion in the City: The Archipelago Effect

Globalization has dramatically disrupted almost all domains of human life. The regulatory bases of Western growth economies – be it Fordism, the welfare state or national institutions for social integration – have been shaken by the new economic model combining competition, flexibility, mobility and individualism. The adaptation, sometimes difficult and at times impossible, of various neighbourhoods and regions to this new economic environment provokes major structural problems within the territories of the different societies; however, it also opens up new opportunities for social actors and citizens (Benko and Liptez, 1992, 2000; Hiernaux, 1999).

Globalization and the changes in economic conditions that come with it ushered in a new model of knowledge-based capitalism that places great emphasis on creative activities, namely, creative services (Miles and Green, 2010; Musterd and Murie, 2010). The basis of this new model resides in multiple networks (Ascher, 1995; Castells, 2004; De Mattos et al., 2005; Sassen, 2007), which span national territories (Badie, 1995; Amin and Thrift, 2002) and which render territorial borders more permeable (Castells, 1997, 1998). These networks host flows that produce territorial reconfiguration at the global (Veltz, 1996; Brenner, 1999) and the local scales (Cox, 1997; Fontan et al., 2005).

These reconfigurations strengthen those territories where power structures, productive
systems and human capital are concentrated, which puts cities and mega-cities at the forefront of globalization (Scott, 2001; Lévy, 2006; Sassen, 2007). However, this does not mean that all the cities’ inhabitants benefit – far from it. The globalized economy, while generating new economic prospects for some, also creates great inequality suffered by others. This is exacerbated by public sector initiatives, which, in efforts to open up the national and regional economies to globalization, slash social programmes and dismantle social development policies. The result is that one segment of the population manages to integrate and do very well in successful networks in the economic sphere (Soja and Scott, 1986; Sassen, 1996; Scott, 2006b), while a significant other segment of the population is excluded from such networks and thereby prevented from benefiting fully from their basic rights as citizens (Castel, 2008; Laville, 2008).

We are thus witnessing a twofold trend affecting cities (Table 27.1). The first one, a spatial trend, concerns the concentration of power in certain spaces of the city (neighbourhoods, zones, corridors). These spaces become the winning areas, at the expense of others (former industrial and manufacturing zones, working class neighbourhoods), which suffer the effects of the crisis of Fordism, lose their main resources and must restructure their economies in order to be revitalized (Fontan et al., 2003; Drewe et al., 2008). The second trend is social: one social segment enjoys the privileges usually extended to citizens, namely, economic safety and social security (although these are increasingly reduced in many national contexts), while another segment is condemned to vulnerability, poverty or exclusion from the job market, services and a quality living environment (Mandanipour et al., 1998). The latter class includes the ‘newly poor’, that is, those who are in the labour market yet whose jobs are poorly paid and precarious (Castel, 2008; Laville, 2008).

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This double trend engenders new socio-territorial divides that affect social cohesion and provoke social fragmentation and atomization (Cameron, 2003; Dutton, 2003; Lees, 2003; Dupuy, 2007; Klein et al., 2009) and generates what is called ‘unfair cities’ (Cassiers and Kesteloot, 2012) or even ‘neoliberal cities’ (Rodriguez and Rodriguez, 2009). Winning areas concentrate connections to global networks, economic and political power centres and a high-income population. However, they also ‘host’ the vulnerability

### Table 27.1 Socio-territorial divides affecting social cohesion in the city in the context of the new economy

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<th>Population segments</th>
<th>Types of spaces</th>
<th>Losing areas</th>
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<td>Gentrification</td>
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<td>Headquarters and major firms</td>
<td>Segregation</td>
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<td>Concentration of wealth and national and international power</td>
<td>Loss of resources</td>
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and the precariousness of some groups of people (immigrants, homeless, single-parent families). Losing areas, for their part, are affected by tensions between gentrification and slumification. In this way, cities become segregated and fragmented spaces (Graham and Marvin, 2001). This has raised the issue of ‘flexicurity’, or how to ensure both security and flexibility (Tremblay, 2008), a particularly pressing issue in the present context of competition.

27.2.2 The Creative Building of Social Cohesion in a Context of Diversity

How can the reduction of social cohesion generated by these territorial reconfigurations be countered? The first impulse would be to re-establish the homogeneity and social solidarity based on Fordism and state regulation that characterized Western societies in the post-war years (that is, the Glorious Thirty Years from 1945 to 1975). However, that goal is neither possible nor desirable in the current context. Many authors insist that the homogeneity and social rigidity that characterized social cohesion under Fordism and the welfare state, although appropriate if development is identified with mass consumption, no longer correspond to the needs and options of contemporary society. Indeed, our societies are characterized by social heterogeneity. Yet, rather than viewing this as negative, some authors recognize the potential for creation and innovation that this holds for the development of communities in the context of globalization (Boltanski and Chiapello, 1999; Scott, 2006a, 2006b). These authors also insist on the importance of finding solutions to the ‘personal branding’ and project-based boundary-less careers that are costly to individual security and cohesion (Tremblay, 2008). Cultural and social differences could thus turn out to be assets for being creative as long as interactions between different groups in the two ‘segments’ of the population are developed and social equity is respected (Jenson, 2002) or put forward as an essential objective, which is a challenge, but not impossible.

The capacity for creating refers to the capacity to create something new, that is, to invent (Scott, 2006b). Creation precedes innovation; and innovation depends on the social acceptance of creation and the spread of its effects or results. At the social level, creation and innovation then merge and come to full fruition (Alter, 2000). Individual creation can turn into social creation, thereby laying the foundation for a whole set of new strategies, experiments and ideas, which are the basis for the implementation of social innovations (Chambon et al., 1982; Klein and Harrisson, 2007; Moulaert and Nussbaumer, 2008; Moulaert et al., 2013). At the scale of the city and its neighbourhoods, social creation can take on multidimensional forms and occur within many fields, among others, the arts, architecture, public spaces, recreational and socio-cultural activities, entrepreneurship, neighbourhood services, political participation and the environment (Landry, 2000).

27.3 AN IMPORTANT MARKER OF THE DEBATE: THE ‘CREATIVE CITY’

While most authors accept the importance of creation for revitalizing urban communities and neighbourhoods, in recent years, the debate on creation and innovation
in urban settings has been focused on the strategy of the ‘creative class’, proposed by Florida (2002), which has been highly criticized and provoked strong opposition from the excluded and deprived to strategies of city development centred on cultural creation (Tremblay and Tremblay, 2010). In this section, we first present the strategy of the creative class. Second, we present a summary of the critiques raised against that strategy, essentially critiques addressing its negative effects on social cohesion. Building on those critiques, we present some fields in which creative experiments take place in more cohesive ways. This shall demonstrate that it is not the creative dimension as such that is contested as a basis of city development but its elitist aspect.

27.3.1 The Creative Class

The relation between creation and the city is well established. Lefebvre (1970) saw the city as the centre of all creation, while Jacobs was the first to talk of the ‘creative city’, in her Cities and Wealth of Nations (1984). But it was Florida (2002) who popularized the notion of the creative city, associating it with the presence of a new ‘creative class’:

> The super-creative core of this new class includes scientists and engineers, university professors, poets and novelists, artists . . . and other opinion-makers . . . Beyond this core group, the creative class also includes ‘creative professionals’ who work in a wide range of knowledge-intensive industries . . . Doing so typically requires a high degree of formal education and thus a high level of human capital. (Florida, 2002, pp. 68–9)

Florida argues that a creative city relies on talent, technology and tolerance – a position supported by many. Florida’s argument is contested, however, on the grounds that his notion of talent is seen to reside rather exclusively within an elite, that is, people with high levels of education. Many consider that this concept does not add anything to the traditional concept of human capital (Shearmur, 2006, amongst others). With the elite thus regarded as the gateway to diversity and creation, Florida calls for massive investments in artistic and cultural amenities and infrastructures to make the city attractive for that so-called creative class, who should in turn stimulate innovation and economic growth.

27.3.2 Cohesive Visions: Social Creativity from the Bottom Up

Florida has inspired many urban governments to invest in prestigious cultural assets. However, his views have also received much criticism from researchers as well as from local actors at the neighbourhood level (Markusen, 2006; Shearmur, 2006; Stern and Seifert, 2007; Gunder and Hillier, 2009). Even though authors and stakeholders credit Florida with having drawn attention to the importance of culture in urban development (Tremblay and Darchen, 2010), many criticize his elitist vision (Shearmur, 2006) and propose a more inclusive vision of urban creation (Perez et al., 2000), while others claim that public support for creative sectors in fact tends to support the ‘industry’ (producers and the like) more than creative workers (Klein and Tremblay, 2010a). In that context, the working conditions of creatives illustrate how their work is conceived in ‘non-cohesive societies’, since these people are often highly educated but work for low wages and under precarious conditions (Menger, 2002). More importantly, cities should not only cater to
Many authors bank on cultural resources and creation to redesign the image of a neighbourhood or to revitalize a city. The goal, they argue, should be to improve the quality of life and social development of all groups of society (Gertler, 2004). ‘Social emancipation’ should be favoured over ‘physical beautification’ (Moulaert et al., 2004), and all social classes, not only the educated, should be seen as capable of creation (Markusen, 2006). Such a perspective calls for a multifaceted strategy as opposed to one oriented only towards a so-called creative class (Tremblay and Darchen, 2010). In the following subsections we present some proposals for a strategy oriented towards social creativity drawn from a survey of works that address cultural creation. These proposals pertain to four fields (arts, public space, identity and social economy) and can be seen as ways to achieve a more cohesive development of cities and neighbourhoods (Table 27.2).

### Table 27.2 Cultural creation and the building of social cohesion in cities

<table>
<thead>
<tr>
<th>Themes</th>
<th>Art creation</th>
<th>Public space and integration</th>
<th>Collective and individual identity</th>
<th>Social economy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Targets</td>
<td>Recognition of social diversity</td>
<td>Reconstruction of social links</td>
<td>Affirmation of the collective self-esteem</td>
<td>Intermediation of development action</td>
</tr>
<tr>
<td>Innovative proposals</td>
<td>Cluster of artists at the neighbourhood level</td>
<td>Resocialization of the public space</td>
<td>Transformation of social stigma</td>
<td>Incubation of solidarity-oriented creation projects</td>
</tr>
<tr>
<td></td>
<td>Interrelation between production, work and cultural life</td>
<td>Promote collective participation in creation and discussion</td>
<td>Affirmation of identity by means of culture</td>
<td>Participation in the decision-making process</td>
</tr>
<tr>
<td></td>
<td>Balance between homogeneity and diversity</td>
<td>Expression of cultural diversity and culture of tolerance</td>
<td>Building a collective identity by means of the public space</td>
<td>Revitalization of devitalized neighbourhoods</td>
</tr>
</tbody>
</table>

The ‘creative class’ and to cultural clusters or sectors, but take into account the global development of the city and its various boroughs and social groups.

Decision-makers at the city level are increasingly becoming aware of the importance of arts and the potential of cultural creation as a factor of inclusion in economic development (Hall, 2000; Landry, 2000; Martens et al., 2014). Many examples illustrate the particular potential of artistic creation for promoting social cohesion and orientating urban communities towards a more cohesive perspective (Scott, 2000; Walshok et al., 2002). The presence of cultural creation in diverse neighbourhoods encourages residents to cross their own internal boundaries within the city, thereby breaking with ghettoization, as shown by the case of Minneapolis-St Paul (Markusen, 2006). This, in turn, promotes heterogeneity and collective learning and creates links among local communities as well as between cultural workers and others groups of the local community (Albrechts, 2005).
Groups of artists can also become attractions for tourism and even commercial pillars in small cities, as is the case in Montemor-o-Novo, Portugal (André and Abreu, 2009), and many others. At the same time, they can be levers for community development and social integration, as is the case for the École nationale du cirque and the Tohu in the Saint-Michel neighbourhood (Trudelle et al., 2015) or the artist-run centres in the Mile-End district (Rantisi and Leslie, 2010), both in Montreal (Tremblay and Pilati, 2008).

Art creation can thus promote communication between different social groups, as shown by the ‘Return of the swallows’ project, a film project realized in a disadvantaged immigrant neighbourhood of Brussels (Dietvorst, 2004) with the aim to raise the self-esteem of residents and promote their social integration. The project directors took the specific views of the residents into consideration, worked around their objectives and realities and gave them an artistic voice in the film. With emphasis on communication and interaction, the project thus promoted the individual and collective creation of the inhabitants and improved their social integration and self-image. Another inspiring example is the Simon Bolivar Symphonic Orchestra, the product of a national support programme for musical training and practice in poor neighbourhoods in Venezuela. This national programme, which contributes to getting thousands of children and youth out of poverty and exclusion, has gained international recognition (Sanchez, 2007; André et al., 2013).

27.3.4 Public Spaces as Integrative Places

Stressing cultural creation and innovation as a way to foster social cohesion-oriented actions in cities involves the valuing of public spaces as a way to build collective interaction and social capital (Segovia, 2007). In principle, public spaces should be open and accessible, allowing for interaction, meetings, social exchange and a great variety of activities by groups with different cultures and social interests (Chelkoff and Thibaud, 1992–1993). However, this accessibility and openness have often been compromised, while precarious jobs and mobility tend to disrupt social links. Individualism, indifference to neighbourhood bonds, fear of stigmatization and violence keep many away from public spaces, accentuating the negative effect of spatial segregation on social links and urban mix (Carrion, 2007). With the insecurity this situation provokes (Cozzani, 2008), the population tends to take refuge in its domestic space. Reinvesting public spaces thus becomes a priority if the goal is to generate social cohesion and thereby resocialization.

Many initiatives show that cultural creation allows for the resocialization of such public spaces (Perez et al., 2000; Segovia, 2007). It reduces acts of vandalism and increases the sense of safety. Cultural creation strengthens the image of the neighbourhood, improves its environment and makes it attractive for the inhabitants and visitors; the economy of the neighbourhood generally improves, with local actors launching projects that call for participation. In this way, residents change their perception of the place they inhabit and develop confidence and interest in their environment (Evans and Shaw, 2004).

Therefore, public spaces can become a place of both diversity and integration (Borja, 2003). Socially reinvested, they generate a shared feeling of belonging (Garcia-Ramon et al., 2004). Moreover, through various means, public space allows for the expression of the citizens concerning their needs and claims (López de Lucio, 2000), which brings social problems to the fore. Interaction also allows the articulation of differences and tensions,
Handbook on the geographies of innovation

which can then be negotiated and give way to social compromises – a crucial component for generating social cohesion (Borja, 2001).

27.3.5 The Perception and Building of a Positive Identity

Social divides refer to more than mere objective inequalities, such as income inequality or quality of the housing. They also rest on perceptions, both of deprived people themselves and of others, which in general are associated with stereotypes and culturally based norms (Young, 1990) and which stigmatize disadvantaged communities (for example, ethnic minorities, unemployed, welfare recipients disabled). This tends to generate feelings of vulnerability, shame and reclusive behaviour, which transform the social divide into social exclusion. While some state programmes provide financial support and guarantee a certain level of well-being to some excluded groups (youth, immigrants, people with low levels of education or others having difficulty integrating the labour market), they cannot alleviate the suffering caused by stigmatization. On the contrary, research by Preteceille (2003) on social housing shows that such programmes can even intensify stigmatization. In the new economic model geared towards improving individual performance and opportunities, such stigmatization can even be stronger, exacerbated by a loss of confidence in the institutions that once ensured integration.

Therefore, the rebuilding of social cohesion calls for a strengthening of self-esteem (individual and collective) and requires collective actions that allow the building of a positive perception of one’s environment, or, as Bassand and Guindani (1983) argue, to transform stigma into a matter of pride. This latter point is, specifically, where cultural creation – and innovative interventions that foster it – can reveal its full potential. In many cities, artistic expression (music, theatre or visual arts) has enabled social groups to affirm their identity and obtain the recognition necessary to support their social integration (Bassand, 1990; Gargurevich, 2002; André et al., 2013). These modes of expression have sometimes led to the reversal of social prejudice against the most deprived groups, and thus to the social recognition of these cultural forms by the elites. Music and dance also play a fundamental cohesive role, as documented by Dos Santos, who cites the case of the samba schools in Brazil and the massive support these receive from the residents of the favelas – even if those same residents are deserting the traditional social and political organizations (left wing political parties, trade unions) created to demand better living conditions from the state. Even if some authors are not convinced of its potential as an effective means of integrating the excluded into society or work (Hage, 2000) – and it is, of course, not always effective – many examples show that artistic expression conveys a claim for social and political recognition and can sometimes lead to successful pursuit of these claims. This situation, of course, varies from one country to another, and while Richard Florida has created a ‘diversity index’ to rank cities, these issues remain the object of debate. Nevertheless, it does seem that in some cities, such as Montreal and several Brazilian cities as well (for example, Rio de Janeiro and Salvador de Bahia), community-based cultural expression such as dance and theatre can lead to inclusion of some communities and to greater social cohesion. This is of course not ensured in all cases.
27.3.6 Incubation of Creation by the Social Economy

Some authors who promote cultural creation as a means for building more inclusive and cohesive cities have proposed that organizations involved in the social and solidarity-based economy (called ‘Economía popular’ in Latin America) may be seen as incubators of social creation experiments and innovation. Even if this type of initiative may differ from one country to the next (Cattani, 2005; La Serna, 2004; Nyssens, 2004; Moulaert and Ailenei, 2005; Bouchard, 2013), they have two common characteristics: on the one hand, they aim to improve conditions for citizens on the economic as well as social levels, and, on the other hand, they are anchored in the local community. In this way, they have the capacity to implement a collective dynamic of social innovation in deprived neighbourhoods (Demoustier, 2004; Kirk and Shutte, 2004). This capacity also translates into a search for recognition as an actor in the cultural domain (Colin and Gauthier, 2008).

In that respect, the example of community economic development corporations (CEDCs) in Montreal is revealing. Since their creation at the end of the 1980s to 2015, CEDCs played an important role in the building of a new economy based on the hybridization of the social economy, the public economy and the market, at the same time that they used creation and culture as a means to reconvert devitalized neighbourhoods (Klein et al., 2010a).

By participating in the clustering of artists, the CEDC brought them together to share experiences and knowledge. Those clusters also gave the artists the means to represent themselves before public bodies as well as the tools for responding to their specific problems. The artists were thus able to operate in a broader organization/network that promoted creativity. In addition to resource-sharing, the CEDC provided the artists with legitimacy and access to information, something they could not have obtained otherwise – in particular, because they, as young creators, lacked the social capital that procures financial credibility as well as an evolved, mature information network. Moreover, the social capital of the CEDC allowed them to receive the support of many social, economic and political organizations. The rebuilding of the Cinema Beaubien (a neighbourhood cinema in Montreal), for instance, has been an emblematic local collective action incubated and supported by a CDEC in Montreal (Tremblay et al., 2014).

With their implication in different types of networks, allowing creators to mobilize a diverse set of actors (diverse origins, local and outside, private and public) for the benefit of the local community, social economy-based organizations can contribute to supporting various cultural and creation-oriented initiatives (Klein and Tremblay, 2010b). We conclude that the social economy can be the basis for the hybridization of many types of cultural initiatives and economic actions, and can promote their integration within innovative area development strategies at the local scale (Moulaert and Nussbaumer, 2008).

27.4 SUPPORTING CREATION FOR A COHESIVE CITY

From the works and cases previously summarized, it is possible to see that the implementation of a culture and creation-oriented urban development strategy should be embedded within a wide vision of development, mobilizing various initiatives at the neighbourhood level and at the broader city scale.
Cultural creation can in fact serve as a basis for a cohesive urban development strategy, provided that such a strategy is part of a larger strategic planning process designed to foster the creative capacities of individuals and their organizations in their diversity, to support local identity and culture (Landry, 2000), and to ensure that cultural creators and the local population are not removed from their own space by a process of gentrification but can instead benefit from the financial advantages accruing to the city from this strategy.

However, the cohesive effect of creation as a source of development cannot be taken for granted, even when disadvantaged groups are front and centre (Villeneuve et al., 2007). As shown by many, creation-gear initiatives in neighbourhoods can easily become an enabler of gentrification rather than of social cohesion (Gertler, 2004). To achieve a cohesive effect, creation and creative activities must be an integral part of the overall vision behind the city’s governance and, more importantly, must ensure the active individual and collective participation of all groups of society and cover the social, economic and political dimensions (Stoker, 1998; Borja, 2003; Colin and Gauthier, 2008).

Cultural creation activities can be strong vehicles for the integration of marginalized groups, we argue in this chapter. Some experiments have shown that these activities are a good way to promote social cohesion, since they can bring together different groups from various social or national origins and facilitate exchanges between these groups. However, we argue that a crucial condition for social cohesion to occur is that the artistic and cultural activities involve the actual participation of the local community, as is the case in some of the cited design, dance or collective painting and sculpture initiatives, rather than being based on passive consumption (Klein and Tremblay, 2010).

Cultural creation – which can be a vector of social disarticulation when harnessed to elite consumption and to commercial innovation processes, the cost of which is only borne by certain communities – thus turns out to be a powerful means for social integration (Raven, 1989; Lacy, 1995), provided that the cultural community is open to the local environment, and that it does not induce gentrification that would ultimately exclude the young or less successful creators from the community due to rent increases. The creation process can build social links within the community, increase self-esteem at an individual and collective level (McCarthy, 2006) and increase safety and respect in the different neighbourhoods (Perez et al., 2000; Sharp, 2007). This is all the more important in neighbourhoods where different economic or ethnic groups cohabit without any interaction between them, a situation that usually gives rise to stigmatization and exclusion.

27.5 CONCLUSION

It is not the idea of the creative city per se that we contest in this chapter, and much less the importance of creativity, but rather an elitist and limited notion of creativity, as well as the very specific role ascribed to it in many of today’s innovation and creativity-driven urban development strategies. The challenge for decision-makers and planners is to ensure that creation in its diverse forms becomes a collective action, even a trigger for improving the quality of life for all citizens, by promoting inclusive projects as well as accessibility to creative processes in all domains and for all citizens.

The issue of ‘consumption of’ versus the ‘participation in’ cultural creation must also
be emphasized. The implementation of cultural activities that truly engage the population is much more important than passive financial support for cultural activities that are often seen as exclusive or oriented towards the best educated and wealthiest. Cultural creation can only serve as a basis for a cohesive urban development strategy if the various populations are enabled to participate and engage actively in the cultural and creative activities themselves rather than simply being passive observers, or worse, totally excluded from the activities.

The development of cultural creation-based activities and initiatives can then contribute to innovative forms of governance that favour the expression of opinions and ideas of the various populations, the confrontation of different ideas and forms of expression, and the development of exchanges between a diversity of populations. However, in order to really participate in the definition of strategies and not only be consulted on ideas from above, civil society must be brought to the table very early and be involved in the organization where strategies are discussed.

Creative, artistic and cultural activities can be used as a way to promote the expression of ideas from the most diverse groups and thereby begin to open up the deliberative processes traditionally dominated by political and economic elites, or even creative elites, such as those supported by the creative class theory. This would ensure a more creative and innovative city, since it is widely recognized that more diversity leads to social creativity and innovation.

NOTES

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1. One of the main critiques is precisely that ‘talent’ and the creatives are attracted to places where economic growth is actually occurring and not the opposite (Shearmur, 2006; Tremblay and Darchen, 2010).

2. This retreat from public space also reduces the possibilities of interaction that, according to Jacobs (1961), are essential for innovation to occur in cities.

3. Presentation at a seminar held at Concordia University, Montreal, 12 December 2008.

4. The government of Québec decided to abolish CDECs in 2015 as part of an austerity-oriented programme of reforms.

5. These urban development strategies often conceptualize creativity as a precursor to commercial innovation processes, or as a type of consumption activity that is attractive to a ‘talented’ elite (whether at the neighbourhood or at the city level).

REFERENCES


Richard Shearmu, Christophe Carrincazeaux and David Doloreux - 9781784710767
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Index

Aachen 146–7, 150, 151
Aamoucke, A. 337
absorptive capacity 32, 47, 51, 79, 106, 157, 282, 374, 392
academic entrepreneurship 57
academic scientists 384
active proximity 113
actor constellations 58
Adams, J. 234
administrative regions 4
agency 293, 296–7, 311, 317, 318, 335
see also change agents; innovative agents; knowledge agents
agglomeration-based policies 82
agglomeration(s) 2, 6, 22, 36, 37, 38, 50, 64–5, 338
see also cities/city regions
aggregate social capital 362
Agrawal, A. 337, 388
agro-technology sector, knowledge sourcing 148, 151
Aguílera, A. 113
Akçomak, I.S. 362
Alconbury 346
Almeida, P. 389
Alnuaimi, T. 389
Amazon 130
amenity-driven urban revitalization 266
Amin, A. 297, 298
Amsterdam 183, 357
Amsterdam Smart City 193–4
analytical knowledge 53, 55, 143, 144, 145, 146, 147, 150, 151, 159, 268
analytical sectors 146–7, 150, 160, 161, 162, 163–4
anchor firms 292, 299, 337, 340, 341
Aoyama, Y. 89
appropriability conditions 32, 33, 35, 36, 37, 38, 39, 48
Apps4BCN 192
Archipelago effect 448–50
Arkansas 303
Arrow, K. 362
art creation 452–3
Arthur, W.B.D. 338
artificial urban intelligence 190
Asheim, B.T. 19, 49, 50, 156
Aslesen, H.W. 126, 376
Aspire Programme 334
associational governance 292, 297, 298, 301, 304
attachment to place 7
Audretsch, D.B. 337, 342, 345, 346
Austin 183
Australia 2, 7, 228, 231, 245–9
Australian Geographer 269
Austria 48, 52, 81, 146–9, 150, 151, 231
automation, and job loss 421
Autor-Levy-Murnane (ALM) hypothesis 421, 422
Ayala, S.G. 422
Baden-Württemberg 48, 49, 53
Bain, A. 2, 221
Ballard, P.A. 109, 110, 125, 132, 135, 136, 137, 257
Bartlett, C.A. 400
Baruffaldi, S.H. 389
Bassand, B. 454
Bathe, H.L. 2, 80, 263, 281, 282, 363, 365
Bauernschuster, S. 362
behavioural change 197
Beijing 52, 69, 232, 327, 375
Bellini, E. 386
belonging 105, 453
Ben-David, J. 224
Berlin 73, 232
Bernala, B. 112
Bès, M.-P. 108
best practice 278, 295, 334
bibliometric data, scientific activities 224, 225, 227
Bioregio 146, 151
biotechnology sector 52, 108, 130, 136, 146–7, 150, 151, 179, 281, 302
Blake, M. 273
Blazek, J. 52
BMW 282–3
Bo-Bo (Bourgeois Bohemia) downturn 267
Boekema, F. 362
Bombardier, J.-A. 171, 172
bonding social capital 279, 280, 282, 284, 361
Bonnet, N. 418
bootmaking cluster (El Paso) 250–51
Booz Allen Hamilton innovation survey 195
borders (regional) 4

463

Richard Shearmu, Christophe Carrincazeaux and David Doloreux - 9781784710767
Downloaded from Elgar Online at 08/06/2018 08:30:26AM via Hungarian Academy of Sciences
Boschma, R. 80, 101, 103, 106, 107, 109, 110, 111, 131, 135, 136, 137, 261, 262, 312, 316, 338
Boston 69, 90, 94, 134, 180, 181, 232
bottom-up RIS approaches 49, 339–40
Bouba-Olga, O. 105
Bourdieu, P. 88, 92–7, 243, 361
Brachert, M. 135
Bradford, N. 289
brain drain 382
Bramwell, A. 289
‘branch plant culture’ 278, 283
Brantley, P. 108
Brazil 228, 230, 231, 236, 237, 454
Breau, S. 48, 418, 425, 435
Brécard, D. 24
Bremen 314
Brennan-Horley, C. 221
Breschi, S. 354, 387, 389
Bresnahan, T.F. 30
Breznitz, S. 342
bricolage 317
bridging social capital 279, 282, 361, 364, 366
broadband 192, 357–8, 360, 362
Brocard, M. 224, 234
Broekel, T. 107, 135, 262
Brown, G.M. 267, 268
Brown, R. 339
Burgers, J. 391
business ecosystems 337, 347
Business Innovation Centres (BICs) 334
business model innovation 24, 25
Cabagnols, A. 27
calculative network capital 256
Calgary 183
Camagni, R. 54, 433
Cambridge Futures 344
Cambridge IT cluster 258, 259, 346, 347
Cambridge Network 344
Cambridge Phenomenon: The Growth of a University Town 340, 344
Cambridge University 339, 342, 344, 345, 347
Cambridgeshire 335, 340–46, 347
Canada 2, 7, 68, 69, 78, 179, 228, 231, 260, 271, 304–5, 419
see also individual cities
Capello, R. 54, 433
capital(s) 92–3
see also economic capital; human capital; social capital
career patterns, digital technology graduates 202–216
Careers of Doctorate Holders (CDH) 384
Carrincazeaux, C. 101
Cass, L. 106, 110
Central and Eastern Europe 51, 382
centripetal forces 245, 252
Chamberlinian monopolistic competition 46, 56
Chaminade, C. 52, 353, 374, 375, 376
Champion, K. 424
change agents 191, 270, 271, 339
Charles, D. 339
Chelleraj, G. 386
Cheng, P. 326
Chicago 69, 181, 357
China 52, 69, 198, 393
migration and innovation 284, 382, 383
regional innovation systems 322–32
science activities 228, 230, 231, 232, 236, 237
see also individual cities
China Star Optoelectronics Technology Co. Ltd (CSOT) 329, 330, 331
Christopherson, S. 242
Cities in Civilization 171
Cities and Wealth of Nations 451
cities/city regions 174–84, 243
economic growth/development 67–8
inter-scalar relations 296
Internet and 359–60
labour market density 181
lack of 428–9
global hierarchy 179–80, 184, 267
globalization and social cohesion 448–50
industrial evolution and life cycle of 175–9
and innovation 63, 171–2
creativity and talent 174, 181–3, 184, 221, 435
entrepreneurship 36
growth 22
patent statistics 68–77
spatial concentration 64–8
knowledge acquisition 144
relatedness 133–4, 135–6, 136–7
see also cohesive cities; creative cities; global cities; innovative cities; intelligent cities; large(r) cities; suburbs
City Deals 345, 346
city size 174–5, 177, 181
Clarysse, B. 337
‘close’ cultural outlooks 90
cluster maps 245–6
cluster policies 82, 83, 252, 255, 312–13, 315, 317
cluster theory 241, 244, 252, 255
clusters/clustering 221
advantages 241
competitiveness 255
Index

Index 465

disadvantages 259
entrepreneurial regions 341
evolution dynamics 337
global relations 114–15
innovation 1, 2, 4, 7, 10, 22, 23, 299
knowledge 35–6
limitations of networks in 258–60
local development 104
neoliberalized policy fashion for 243
poverty 425
resilience 116
territorial anchoring 116–17
see also creative clusters; industrial clusters; regional clusters
co-ethnicity 388
coevolution, proximities and knowledge networks 110, 257
coinnovation 117, 325
coinvention 30
colocation 1, 5–6, 63, 64, 65, 66, 82, 107, 182, 184, 299, 363, 365, 408, 434
coproduction of knowledge 131, 132
Cockburn, I. 337
codified knowledge 35, 53, 66, 129, 143
Coe, N.M. 324
Coenen, L. 50
cognitive competence 190
cognitive distance 128
cognitive proximity 54, 80, 106, 110–111, 128, 132, 142, 160, 261, 262
cognitive skills 31, 32
cognitive-cultural economy 182, 183, 266–7
Cohen, W.M. 32
Cohendet, P. 116, 263
cohesive cities 447, 455–6
see also cooperation; Goldilocks principle; partnerships

collaboration networks 30, 109, 161, 193, 235, 280, 282, 312, 374, 375

collective action 338, 454

collective learning 79, 82, 257, 278, 295, 452

collective local culture 91
Colombelli, A. 136
commercialization 342
communication 90, 111, 128, 160, 436, 453
communities of practice 38, 257
community economic development corporations (CEDCs) 304, 455
community intelligence 192–3
commuting patterns 4
comparative advantage(s) 46, 56, 137, 300, 326, 327, 385, 391

cost-benefit networks 38

competencies 28, 29, 176, 267, 278, 279, 295, 373, 374, 420
complementary 110–111
multinational corporations 403, 404, 405, 407
see also organizational competences; policy competences; scientific competence
competition 23, 27, 46, 56, 177, 198, 337, 358
competitive advantage(s) 10, 46, 56, 64, 187, 266, 295, 312, 373
competitiveness 46, 47, 56, 148, 255, 295, 330
competitor observation 164, 165
complementarities 30, 31, 32, 58
Complex and Combined Innovation (CCI) mode 280
Comptour, F. 82
corporate strategy 437
creation and innovation 447, 450
doctor of social cohesion 450
see also cultural creation; knowledge creation; path creation; social creation; value creation
creative cities 183, 267–8, 272, 450–55
creative class 201, 202, 423–4, 451
creative clusters 244, 251
creative destruction 419, 420–21, 422, 436, 440, 443
creative industries 159–60, 201, 423
digital technology skills (study) 202–215
role in suburban development 269
creative innovation 243
Creative Margins: Cultural Production in Canadian Suburbs 269
Creative suburbia: cultural research and suburban geographies 269
creative suburbs 268–70
creativity
in the cognitive-cultural economy 266–7
and inequality 424
and innovation 1, 2
in cities see cities/city regions
location and 5
territorial anchoring 116–17
Creativity in Peripheral Places: Redefining the Creative Industries 269
Crépon, B. 25, 26
Cresco, J. 116, 313
Crevoisier, O. 2
critical mass 11, 79, 181, 233–6, 440
cross-border RIS 52
cross-fertilization 176–7, 268
cultural activities 184, 272, 450, 456, 457
cultural capital 92, 267
cultural capitalism 250, 251
cultural conflict 91, 97
cultural contexts 47, 90, 92, 142, 150
cultural creation 452–7
cultural determinism 88
cultural diversity 386, 391
cultural embeddedness 53, 88–97, 242
cultural heterogeneity 91
cultural infrastructure 267, 270, 272, 451
cultural innovation 2
cultural intermediaries 243
cultural outlooks 89, 90, 91
cultural production (suburban) 270
cultural proximity 90–91
cultural structures 88, 89
cultural urbanism 266
culture
of creative cities 267
of innovation 89–92, 326
of researchers/geographers 7
see also innovative cultures; local culture;
multiple cultures; organizational
culture; transformational culture
cumulativeness conditions 32, 33, 34, 35, 36, 37, 38, 39
Cunningham, S. 203
customer involvement 24
Czech Republic 52, 231
Darwin 245–9, 252
databases 3
Dauvin, M. 358
David, P.A. 382
Dawley, S. 314
delocalization of innovation 370
decision-making 7, 337
‘The decision on accelerating the development of strategic emerging industries’ 325–6
decomposition 78, 229–33, 237
demand-side of innovation 52
Denmark 52, 231, 317, 357, 419
density index 134
Denver 96
Department of Culture, Media and sport (DCMS) 201, 202
design innovation 24, 25
Detroit 95, 179
developing countries 51
diaspora networks 388, 389, 390
Digital Agenda for Europe 192
digital applications, city life 192–3, 196–7
Digital Equipment Corporation (Boston) 90
digital social capital 361–5
digital space (urban) 190, 192, 194–5
digital technology skills, in creative sector (study) 202–216
diminishing returns 101, 112, 116, 117–18
DIOC database 383, 384
directionality failure 58
dirigist production networks 327
dirigist RIS 49–50
disembeddedness 402, 403, 404, 405, 434
placement 420, 424
disruptive business model 130
disruptive innovation 25, 189
distance 2, 3, 6, 7, 47, 52, 65, 371
distance decay 67, 358
diversification 64, 111, 136, 137, 151, 177, 178, 237, 324, 440
diversified RIS 57
diversity
creative building of social cohesion 450
and global hierarchy of cities 179–80
see also cultural diversity; urban diversity
diversity index 454
Doing, Using and Interaction (DUI) mode 46, 279, 280, 281, 283–4
Doloreux, D. 2, 434, 439
domestic linkages 81
Donegan, M. 425
Dongguan 327
Doz, Y.L. 400
Duranton, G. 177
dynamic capabilities 28–9
dynamic perspective, of proximities 110

East Asia 383, 384, 393
see also China; Japan; South Korea; Taiwan

Ebbeck, M. 317
Echeverri-Carroll, E. 422
ecological fallacy 434–5
economic activity 90, 107–8, 182, 183
economic capital 51, 92
economic change 420–21
economic competition 27
economic development
creation and innovation 447
institutions and 293
Internet infrastructure and 359–60
peripheral areas 81–4
see also local development; regional development
economic diversification 324
economic geography
contribution of RIS to 49–54
globalizing innovation-related activities 371
innovation, R&D and knowledge spillovers 22–40
networks in 256
see also evolutionary approaches; geography of innovation
economic governance 297–8
economic growth 46
cities see cities/city regions
cluster model 7
entrepreneurial activity 337, 342
and innovation 1, 22
inter-scalar relations 296
Internet and 359–61
knowledge 176, 295
technology-intensive manufacturing 182
see also endogenous growth theory
economies of scale 47, 64, 82, 401, 440
ecosystems 24, 116, 196, 302–4, 337, 338–9, 345, 347
efficacy 28
efficiency 28, 440
El Paso 250–51
Ellwanger, N. 111
embeddedness 47, 54, 90, 196, 302, 309, 317
see also cultural embeddedness;
disembeddedness; local embeddedness;
regional embeddedness; social embeddedness; spatial embeddedness;
territorial embeddedness
embodied knowledge 11, 28, 32
emergent RIS 51
emerging economies 323, 324, 370, 374
emerging geography of innovation 77–84
Emilia-Romagna 48, 53
empirical reality 7
employment 25, 26, 182, 206–15, 340, 341, 360, 425–6, 440
‘empty the cage for new birds’ strategy 328
endogenous growth theory 24, 359, 434, 435–7
entrepreneurial ecosystem approach 338–9, 345
entrepreneurial identity 96
entrepreneurial performance hypothesis 337
entrepreneurial process of discovery 302
entrepreneurial regions 334–47
coordinated activity 339–40
entrepreneurs and entrepreneurial resources 336–7
growth and vision 338–9
Oxfordshire and Cambridgeshire 335, 340–46, 347
entrepreneurial RIS 50
entrepreneurship 36, 96, 335–7
Ernst, D. 371
Essletzbichler, J. 313
ethnic inventor groups 386–7, 388–9
ethnic-bound knowledge spillovers 387–8, 389
ethnic/national/personal fields 94, 95
Etzkowitz, H. 338
Europe 36, 51, 68, 69, 82, 260, 357, 425
innovation
and creativity in city regions 179, 183, 184
global networks (GINs) 373, 374
relatedness and 136, 137, 138
innovation policy 433
regional economic development 294
see also individual countries
European Entrepreneurial Region (EER) 334, 347
European Union (EU) 27, 188, 230, 301–2, 315, 334
Eurostat 4, 340
evolutionary approaches
path dependence 56, 311–16, 338
relatedness and related variety 128
to proximities 110
exogenous growth/development 57, 283
experience-based knowledge 280, 281, 283
expertise 157, 160, 178
explicit knowledge 159, 160
exploitation 29
exploration 29
export performance 26, 27
export-led growth 325, 327
external energy 54
external knowledge 65, 66, 79, 83, 106, 160
acquisition 142, 145, 151, 157
sources 34, 38, 159, 296
spillovers 22
external networks 54
externalities 82, 177
extra-local connectivity 80, 83
extra-regional knowledge 54, 57, 111, 281–3, 284
face-to-face communication 160, 363
face-to-face interaction(s) 66, 113–14, 144, 243, 244, 261, 268, 301, 363, 364, 365, 391, 401
Facebook 362
Farsund Aluminium Casting (FAC) 282–3
fast policy transfer 301
Feld, B. 339
Feldman, M. 337, 338
Ferrary, M. 108
Ferru, M. 6, 10, 20, 101, 108
Ferrucci, L. 283
fields
of innovation 93–7, 243
of practice 92–3
Finland 148, 149, 150, 231
firm adaptation 10
firm ecosystems 24
firm innovation
co-location and 1
cultural diversity of TMTs 391
dependencies 32, 159
knowledge characteristics 33–4
local development 439–42
resource-based model and strategic management 27–32
in unconducive environments 11
see also multinational corporations
firm size 26, 27
firm-level productivity 23–7, 29–30, 32
Fischer, C.S. 108
Fitjar, R.D. 66, 81, 82, 156, 164, 221, 259, 260, 261, 364
Flanagan, K. 289, 318
flat panel display (FPD) technology 329
Florida, R. 171, 182, 201, 243, 266, 267, 423, 424, 433, 451, 454
Foley, C.F. 389
Food Network initiative 334
Foray, D. 302, 313
Fordism 449, 450
foreign direct investment (FDI) 51, 322, 323, 326, 327, 400
foreign firms 27
foreign innovation channels 163–4
foreign inventor groups 387
formal institutions 155, 293
formal inter-organizational networks 256
formal relationships 163, 164
Fornahl, D. 314
Fowler, C. 425
fragmentation 50, 55, 57, 195, 449
France 27, 70–73, 77, 78, 228, 231, 232, 234, 236, 339, 382, 384, 387, 391, 419
Francis, J.L. 338
Frankfurt 73, 179, 357
free riding 34, 297
Freeman, C. 34
French School of Proximity 2, 80, 100–101, 103, 109, 114, 434
Frenken, K. 106, 109, 261
Fritsch, M. 334, 337
functional regions 4–5
Garnham, N. 159
Garnsey, E. 342
Garud, R. 317, 318
gatekeepers 146, 172, 245, 282
Gauthier-Loiselle, M. 386
GDP growth 436
Gee, S. 314
Geels, F.W. 93
general purpose technologies (GPTs) 12, 31
see also Internet
generalization, from successful regions 10–11
gentrification 273, 420, 424, 456
generators 7–8
geographical proximity 105, 106, 107, 108, 110
facilitation of non-geographical proximities 262
innovation/capability 156, 187
interactive learning 54
knowledge availability 142
exchange 1–2, 47
firms’ dependence 159
transfer 365
and RIS 49
social networks 48
symbolic industries 160
three forms 113
geography 3
geography(ies) of innovation
accepted truths 1
China 325–6
concepts 4–6
early research 1–2
generators 7–8
importance of networks 354
influence on degree of novelty 374–6
knowledge bases 53
motivation for current work 3
in multinational corporations 399–409
new research 2
proximity dynamics 100–118
relatedness 127–38
scientific activities 223–37
six confusions 8–12
understanding and learning from evolving 63–84
unevenness 88
Germany 48, 50, 73–4, 77, 135, 228, 230, 231, 232, 383, 384, 387, 391
see also individual cities
Gertler, M.S. 47, 293
Ghoshal, S. 400
Gianelle, C. 137, 312, 316
Gibson, C. 2, 221, 269, 271
Glaeser, E.L. 125, 134, 174, 182, 362
global cities 179–80, 229, 357
global division of labour 179
global economic crisis 322–3, 324, 325
globalized economy 114, 179, 180, 184, 295, 299, 322–3, 449
global hierarchy of cities 179–80, 184, 267
Global Innovation 1000 survey 195
global innovation networks (GINs) 47, 57, 353, 370–77
geography of 373–6
as a new phenomenon 370–73
research agenda 376–7
global knowledge flows 159, 174, 180
global networks 160, 260–61, 295, 449
Global North 2, 7, 51, 323
global pipelines 258, 282, 364
global platforms 192–3, 195
global production networks (GPNs) 57, 81, 324, 325, 327, 328, 329, 331, 353, 371, 372
global relations 114–15
Global South 51, 323
global ties 364
global value chains (GVCs) 156, 324, 325, 328, 353, 371, 372, 437
globalization 57, 114, 174, 292, 293, 296, 310, 324, 357, 448–50
globalized companies 160
GlobSci survey 384, 389
Glückler, J. 263
Goldilocks principle 261–2, 263
Gordon, I.R. 37
governance
cultural creation and innovative 457
entrepreneurial regions 343–5
and innovation 151, 195, 292, 293, 294, 297–8, 301
regional-level 48, 49, 339
see also multi-level governance
Granovetter, M.S. 90, 107, 108
grassroots RIS 49
Greater Cambridge-Greater Peterborough Enterprise Partnership 345
Greece 230, 231, 384
Green Card 391
Greenstein, S. 30
GREMI 104
Griffith, R. 27
Griliches, Z. 24, 25, 26, 111
Grillitsch, M. 2, 19, 81, 83, 145
Grindley, P.C. 37
Grossetti, M. 105, 107, 108
Growing Places Fund 346
Gruber, H. 358
Grubesic, T.H. 358
Grzybowski, L. 358
Guangdong 328
Guangzhou 69
Guindani, S. 454
Gulbrandsen, I.T. 361
habitus 93, 94, 96
Hall, B.H. 26, 132
Hall, P. 171, 179, 229, 267
Halpern, L. 26
Hanson, S. 273
hard infrastructure 191
hard institutionalism 301
Harirchi, G. 376
Harris, J. 224
Harwell Science and Innovation Campus 346
Hassink, R. 146
Haussmann, R. 137
Hedlund, G. 400
Heimeriks, G. 136
Helsinki 149, 150
Henning, M. 311
Hess, M. 324
Hidalgo, C. 127, 130, 131, 132, 137, 138
high-tech entrepreneurial regions 335, 340–46
high-tech firms 182
high-tech industries 31
higher-level networks 256
highly skilled migrants 387–93
highly skilled migration 354, 382, 383–4
historical legacies 135, 250–51
historical sociology of science 224
Horizons 344
horizontal networks 48
Hornung, E. 382
Howells, J. 48
Huber, F. 2, 221, 256, 257, 259, 261, 262, 364
Handbook on the geographies of innovation

Huggins, R. 256
Hungary 52, 231
Hunt, J. 386
hybrid innovation ecosystems 196
Hymer, S. 179
Iacobucci, D. 339–40
Iammarino, S. 37, 38
ICOS repository 192
idealized views, of entrepreneurship 96
ideas 2, 176–7, 457
identity, cultural creation and positive 454
imaginary(ies) 7, 244, 269, 299
imitation 24, 28, 35, 36
implementation, of IT 31
in-migrant workers 337
incremental innovation(s) 10, 25, 50, 53, 56, 145, 149, 280, 283, 284, 302
incremental phase 165
India 52, 69, 198, 228, 230, 231, 323, 373, 376, 382, 383, 384, 388, 391, 393
indigenous innovation 325, 326, 327–31
individualized networks 257
industrial atmosphere 258, 403
industrial clusters 36–8, 49, 296, 363, 364
industrial complexes 37, 38
industrial districts 47, 49, 104, 183, 189, 243
‘industrial model’ of the firm 29
industrial revolution 171, 427–8
inequality
  globalization and 449
  innovation and 68, 420–23
  negative consequences 419–20
  in OECD countries 419
  poverty and the labour market 425–9
inertia 310
informal community cultural service hubs 270
informal institutions 155, 293
  see also norms; routines
informal knowledge flows 160
informal networks/networking 54, 89, 142, 364
informal relations 108, 163, 164, 256
information and communications technology (ICT) 29, 134
  -mediated interaction 363
Austrian firms and non-local knowledge 81
economic effect 359
effect on global pipelines 364–5
external investment, Sardinia 283
global innovation networks 374, 376
industry-level impact 30–32
innovative cities 195
investments 30
knowledge sourcing 147–8, 150, 151
renewal of RIS dominated industries 52
Silicon Valley 136
social capital 362
see also Internet
information spillovers 2
information-intensive industrial activity 179
INGINEUS survey 376
INNOVARE 432
‘innovating region’ concept 337, 345
innovation
capability 164
and cities see cities/city regions
creation and 447, 450
ecosystems 302–4
and growth see economic growth
importance of regional conditions 156–7
local consequences 419–29
measurement of 1, 437–9
migration and 382–94
networks see network(s)
performance 47, 52, 107, 136, 278, 279, 298
protection of 33, 35
see also firm innovation; geography(ies) of innovation; local innovation; regional innovation
innovation circuits 194–7
innovation flows 54
innovation hubs 64, 70, 74, 181–3, 244, 303
innovation policy(ies)
  drug analogy 315–16
  emerging geography of innovation and implications for 81–4
Europe 433
integration of regional policy and 432
knowledge circulation/exchange 46
and regional advantage 49, 51
  see also regional innovation systems
research in 289
territorialized 105
theoretical basis 155
  see also regional development policy(ies)
intraurban innovation contexts 52
innovation support networks 343–4
innovation system approach 46–7, 294–5
innovation-prone societies 66, 67
innovative agents 9–10
innovative cities 267–8, 422, 425–6, 457
innovative cultures 89–92
innovative entrepreneurs 8–9
innovative fields 93–7
innovative milieus 47, 49, 54, 104, 196, 295, 299, 433
innovative regions 8–9
Index 471

International Journal of Sustainable Development 101
internationalization, scientific activities 235–7
Internet 1, 12, 192, 356–66
digital social capital 361–5
geographies of 356–8
infrastructure 358, 359–60
local economic growth 359–61
interpersonal relations/networks 107, 108, 243, 271
Invest in Growth Hub 345
inward knowledge spillovers 38–9
Isaksen, A. 49, 126, 222, 280, 338
Isard, W. 435
Italy 48, 49, 180, 183, 231, 340, 383, 384, 389
Jacobs, J. 171, 172, 176, 177, 182, 451
Jaffe, A.B. 36
James, A. 89, 90, 96
Japan 74–6, 77, 78, 228, 230, 231, 232, 329, 330, 373, 384, 387
Jeanerat, H. 2
job hierarchy 256, 259
job loss 421
Jöns, H. 224
Just, S.N. 361
Karlsen, J. 222, 280
Karnøe, P. 317
Keilbach, M. 337, 342, 345, 346
Kerr, W. 386, 388, 389
key enabling technologies 302
Klett, R. 425
Klofsten, M. 338
know what 159
know why 159
know-how 28, 159, 160, 392, 443
know-who 159, 160
knowledge accessibility 32, 34–5, 37, 259
accumulation 127
availability 142, 143, 144, 147, 150, 376
economic growth 295
exploitation 48, 51, 57, 282, 295
exploration 48, 49, 51, 57, 295
externalities 5, 33, 38, 66, 78, 82, 125
investments 35
mobilization 295, 304
research-based 156, 159, 160
spatial dynamics see relatedness
technological regimes and innovation 32–6
see also analytical knowledge; codified
knowledge; external knowledge; extra-regional knowledge; local knowledge;
new knowledge; pre-existing knowledge;

inputs (firm) 29
Institutes for Manufacturing Innovation (IMIs) 303–4
institution(s)
culture as 89
knowledge-related 22
regional innovation 292, 293–300
see also formal institutions; informal institutions
institutional capture 324
institutional change 316–17
institutional contexts 47, 159
institutional cooperation 190
institutional differences 110
institutional distance 52
institutional economic geography 311
institutional embeddedness 53, 298, 403
institutional infrastructure 181, 292, 403
institutional intermediaries 298, 304–5
institutional lock-in 301, 310, 324, 404
institutional perspective 338
institutional proximity 54, 80, 105, 106, 142, 261
institutional RIS 50
institutional thickness 144, 196, 268, 278, 279, 300, 301, 309, 310, 374
institutional turn 310
intangible assets 28
integrated innovation 52
intellectual capacity 195
see also patents/patenting
intelligent cities 187–98
formation 191–4
fundamental operation of 194–7
literature and concept 188–91
problem-focused approach 197–8
Intelligent Community Forum 191
intelligent machinery, knowledge sourcing 148, 150, 151
Intelligent Nation 2015 Masterplan 193
inter-firm mobility 337
inter-organizational networks 255, 256, 257, 258, 263
inter-organizational partnerships 364
interactionist approach, proximity 105
interactive learning 1, 47, 48, 53, 54, 80, 111, 146, 159, 279, 323
interdependencies 46, 47, 51, 54, 160, 196, 267, 402, 403
intermediaries 24, 243, 298, 304–5
internal information processing 193
international connections 81
International Journal of Cultural Studies 269
International Journal of Sustainable Development 101
internationalization, scientific activities 235–7
Internet 1, 12, 192, 356–66
digital social capital 361–5
geographies of 356–8
infrastructure 358, 359–60
local economic growth 359–61
interpersonal relations/networks 107, 108, 243, 271
Invest in Growth Hub 345
inward knowledge spillovers 38–9
Isaksen, A. 49, 126, 222, 280, 338
Isard, W. 435
Italy 48, 49, 180, 183, 231, 340, 383, 384, 389
Jacobs, J. 171, 172, 176, 177, 182, 451
Jaffe, A.B. 36
James, A. 89, 90, 96
Japan 74–6, 77, 78, 228, 230, 231, 232, 329, 330, 373, 384, 387
Jeanerat, H. 2
job hierarchy 256, 259
job loss 421
Jöns, H. 224
Just, S.N. 361
Karlsen, J. 222, 280
Karnøe, P. 317
Keilbach, M. 337, 342, 345, 346
Kerr, W. 386, 388, 389
key enabling technologies 302
Klett, R. 425
Klofsten, M. 338
know what 159
know why 159
know-how 28, 159, 160, 392, 443
know-who 159, 160
knowledge accessibility 32, 34–5, 37, 259
accumulation 127
availability 142, 143, 144, 147, 150, 376
economic growth 295
exploitation 48, 51, 57, 282, 295
exploration 48, 49, 51, 57, 295
externalities 5, 33, 38, 66, 78, 82, 125
investments 35
mobilization 295, 304
research-based 156, 159, 160
spatial dynamics see relatedness
technological regimes and innovation 32–6
see also analytical knowledge; codified
knowledge; external knowledge; extra-regional knowledge; local knowledge;
new knowledge; pre-existing knowledge;
symbolic knowledge; synthetic knowledge; tacit knowledge
knowledge acquisition 24, 26, 29, 54, 91
global networks 261
sectoral and regional contexts (study) 142–51
knowledge agents 34
knowledge assets 27–8, 178, 295, 299
knowledge bases 11, 49, 52–3, 55, 157–8
combinations and innovation 143
global networks 371
mapping of 127–8, 130
knowledge creation 2, 11, 45, 174, 178, 274
knowledge diffusion 11, 29, 35, 66, 82, 174, 178, 295, 390, 391
knowledge domains 32
knowledge economics 27, 31
knowledge economy 46, 47, 129, 143, 298, 299, 301
knowledge exchange 47, 53, 63, 106, 129, 145, 147, 157
across large distances 371
bonding social capital 279
diaspora networks 390
information policy and 46
MNCs and 400
proximity and 65–6, 79–80
regional innovation systems (RIS) 278
see also local knowledge, exchange; tacit knowledge, exchange
knowledge flows
colocation 63
costs of unintended 37
distance decay 67
global 159, 174, 180
informal 38, 160
and innovation 181, 187
local 81, 83, 183, 281
non-local 57
regional innovation systems 52, 53–4, 155, 156
social capital 362
spatiality 65, 125
technical 256
in urban centres 180
knowledge generation 57, 63, 67, 177
knowledge hubs 180
knowledge infrastructure 47, 64, 146, 178, 280, 299
knowledge links 156
knowledge management 26, 28, 29–30
‘knowledge model’ of the firm 29
knowledge networks 54, 112, 131, 138, 156, 255, 295
global 160, 295
knowledge bases 371
proximity and 110, 128, 257
knowledge production 127, 128, 129, 131, 132, 136
knowledge proximity 111, 196
knowledge recombination 312
knowledge relationships 148, 257, 318
knowledge remittances 387–90
knowledge sharing 26, 80, 90, 94, 97, 112, 257, 282, 295, 303
knowledge sources 27, 34, 38, 47, 54, 159
knowledge sourcing
in analytical sectors 146–7, 150
extra-regional 281–3, 284
and job position 256
regional contexts 143–4
in symbolic sectors 148–9, 150–51
in synthetic sectors 147–8, 150, 151
knowledge space 127–8, 130–34, 135, 137, 138
knowledge spillovers 89, 181, 182, 196, 255
conformity and 279
and entrepreneurship 336–7, 345, 347
ethnic-bound 387–8, 389
and growth 176
and knowledge acquisition 150
protection against 39
R&D and innovation 23, 26, 27, 35, 36–9
spatial limit to 65
technological 257
untraded linkages 54
see also external knowledge, spillovers; local knowledge, spillovers
knowledge structures 129, 130, 133, 134, 136, 137
knowledge transfer 47, 53, 129, 174, 176, 181, 300, 304, 311
differentiation of static/dynamic aspects 54
global pipelines 364
intra-company mobility 390
MNCs and 392, 401
proximity and 65, 79–80, 128
relatedness 136
social relations 362
see also local knowledge, transfer; tacit knowledge, transfer
knowledge transferability 142, 143, 144, 145, 376
knowledge transmission 34, 35, 38, 159, 174
knowledge value 11
knowledge workers 48, 129, 257, 267
knowledge-intensive business service (KIBS) 360
knowledge-intensive industries/services 48, 174, 180, 182, 303, 425
knowledge-productivity 26
Index

Kobayashi, K. 282
Kogler, D.F. 135
Kolko, J. 360
Komninos, N. 171, 189
Koutroumpis, P. 358
Krätke, S. 418, 435
Kremp, E. 26
KREO project 344
Kuhn, P. 392

labour market 4, 47, 181, 182, 259, 384, 421–2, 425–9
see also employment; skilled workers
labour mobility 57, 89, 129, 149, 176, 312, 337
labour productivity 24, 26, 30
Lagendijk, A. 317
Landoni, P. 389
large(r) cities 10, 66, 174, 177, 184, 268, 436, 440, 443
Latin America 82
Lawson, T. 316
Lawton Smith, H. 290
Le Bas, C. 27
Leadbeater, C. 243
learning regions 66
learning-by-doing 46, 160, 363
learning-by-observing 176
learning/learning processes 1, 28, 32, 33, 34, 46, 50, 91, 111, 125, 160, 196, 277, 317, 401
see also collective learning; interactive learning; policy learning; social learning
least developed countries (LDCs) 322, 323
Lee, N. 2, 68, 418, 425
Lefebvre, H. 451
legitimacy, norms of 93
Levin, S.G. 385, 386
Levinthal, D.A. 32
Levy, R. 112
licensing 24
Lindblom, C.E. 317
linear model of innovation 46, 53, 88
liquid crystal display industry 329–31
Lisbon 334
Lissoni, F. 48
List, F. 382
Lister 280–81, 282
Liu, X. 326
Livingstone, D. 224
local action register 114
‘local buzz and pipelines’ metaphor 14, 54, 82, 281–2, 363–4
local culture 97
local development clusters and 104
local innovation and 433–5, 439–42
deploy 443
local embeddedness 268, 310, 311, 323
Local Enterprise Partnerships (LEPs) 345
local fields 94, 95–6
local GDP, as a measure of innovation 439
local innovation 11 and local development 433–5, 439–42
partners 162
and regional development 9–10
local interactions 104
local knowledge 2, 80, 143, 146, 178, 280–81
availability 142
development 160
exchange 282
flows 81, 83, 183, 281
spillovers 32, 36, 37, 38, 39, 81, 83, 257
transfer 129
local learning 160
local networks 162, 165, 259–60, 293, 373
localization entrepreneurial activity 336–7
deploy 48
see also de-localization
location 5, 6, 376
locational decisions 39, 181, 182, 183, 292, 293, 295, 296
lock-in 55, 57, 116, 301, 310, 311, 313, 324, 404
London 179, 180, 183, 198, 201, 209, 211–12, 214, 259, 357, 425
long-term economic growth 436
Lorentzen, A. 101
Los Angeles 68, 69, 180, 250, 357
losing areas 447, 450
low-skilled workers, employment 425–6
Lowe, N. 425
lower-level networks 256
Luddites 417, 421
Lundquist 52
Lundvall, B.-A. 155, 433
Luxembourg Income Survey 425
McAusland, C. 392
McCann, P. 2, 19, 37, 38, 433, 434
Mack, E.A. 360
MacKinnon, D. 313
Madrid 232
Mairesse, J. 25, 26, 27
Maisonobe, M. 109
Malecki, E.J. 361–2, 435
Malerba, F. 32, 34
Malmö 47, 257
Malmö 149, 150, 151
managerial abilities 31
managerial innovation 25
Mannheim 73
Mansfield, E. 24
Manville, K. 181
mapping, knowledge space 127–8, 130, 135, 137
market competition 23
market feedbacks 34
market knowledge 90, 149
‘market for technology’ policy 325
marketing innovation 25
Marshall, A. 47, 176, 257
Martin Prosperity Institute 266
Martin, R. 164, 277, 311–12, 313, 315
Martino, G. 425
Marx, K. 171
mash-up applications 196–7
Maskell, P. 47, 257
Mason, C. 339
Massard, N. 101
Massey, D. 5, 347, 437
Mates, J. 353, 354
Matthiessen, C. 224, 229
media richness 363
Medium to Long-term Plan (MLP) 325, 329
Mehier, S. 101
Meijering, L. 391
metropolitan regions see cities/city regions
Mexico 76–7, 78, 231
Meyer, J.B. 390
micro-local spaces 5
microeconometric studies 26
migration, and innovation 382–9
conclusions and further research 393–4
in destination countries 382, 385–7
highly skilled 354, 383–4, 390–93
in origin countries 382–3, 387–90
Miguélez, E. 389
Milan 180, 183
Milton Park 346
Mitchell, W. 190
mobile communications 12, 364
mobile creative elite 171
mobility 5, 353
see also labour mobility; migration;
transitional mobility; virtual mobility
Mohnen, P. 26
Mohr, V. 342
monopolistic competition 46, 56
Montgomery, J. 178
Montreal 69, 116, 180, 432, 453, 455
Moretti, E. 182
Morgan, K. 314–15
Mormon workers 96
Moscow 232
Moser, P. 382
Mudambi, R. 37
muddling through 317
multi-level governance 49, 298, 299–300, 304, 339
multi-scalar perspective 115, 258, 313–14, 353, 376
multinational corporations (MNCs) 22, 187, 354, 370, 399–409
global division of labour 179
innovation
dispersal and concentration of 400–402
globalization and regional embeddedness of 402–5
migration and 389, 391, 392, 393
projects and arenas 405–8
multiple cultures 91–2
municipalities 4, 5
Muraközy, B. 26
mutual learning 401

Nadiri, M.J. 26
nanotechnology sector 130, 136, 146, 302, 303
narrative(s) 2, 108, 318
Nathan, M. 386
national contextual conditions 52
national innovation strategies 274
national innovation surveys 10
national innovation systems 49–50, 53–4, 89, 433
national institutional framework, and RIS development 50
National Network of Manufacturing Institutes (NNMI) 303
Ndabeni, L. 2
Nelson, R.R. 24, 311
neoliberal cities 449
neoliberalization 438
NESTA 202, 203
Netherlands 107, 231, 384, 387, 391
network(s)
as an entrepreneurial resource 344
formation 107, 312
importance to geography of innovation 354
knowledge exchange through embeddedness of 268
knowledge sourcing 151
limitations of, in clusters 258–60
mechanisms 256–7
national contextual conditions 52
personal and formal 255–7
see also collaboration networks; knowledge networks; knowledge space; social networks
network analysis 109–111, 116, 135, 376
network topology maps 246
networked relations 241, 246, 295, 301
networking 93, 94, 96, 149, 187, 243, 246, 263
new discoveries 29
‘new economics of innovation’ 257–8
new economy sectors 178, 179
new knowledge 1, 53, 58, 91, 111, 128, 129–30, 177, 268, 336, 392, 400, 401
new media sector, knowledge sourcing in 148–9, 150–51, 151
new model innovation agencies 303
New Regionalism 292, 293–301
new technology(ies) 179, 183, 419, 421, 428
New York 69, 179, 180, 181, 183, 232, 303, 357, 386
New Zealand 231
Nicotra, M. 337
Niebuhr, A. 386
Nilsson, M. 2, 81, 83, 145
non-clustered activity 221–2
non-creative sectors, digital technology graduate employment 209, 214
non-local fields 95
non-local knowledge 57, 67, 79, 80, 81, 146, 149
non-physical proximity 105
non-spatial proximities 105, 107, 110
non-successful regions 10–11
non-technological innovation 24, 25
Nooteboom, B. 106, 262
norms 48, 93, 94, 361
North, D. 106
Norway 78, 81, 161–5, 231, 259, 262–3, 280–81, 282, 376
Norwegian University of Science and Technology (NTNU) 283
novel innovator 25
novelty 56, 132, 375, 376, 417
Ó hUallacháin, B. 68
Oakley, K. 243
observation of competitors 164, 165
OECD countries 292, 294, 295, 384, 394, 419
Ohio 303
online social networks (OSN) 356, 358, 361, 362–5, 366
Ontario 304
open culture 90
open innovation 47, 91, 117, 193
opportunity conditions 32, 34
Organisation for Economic Co-operation and Development (OECD) 46, 280, 304, 432, 437
see also OECD countries
organizational capabilities 34, 52, 295
organizational change 31
organizational competences 28, 47
organizational complementarities 30
organizational culture 90, 91, 92, 94, 95, 97
organizational fields 94, 95, 96
organizational innovation 25
organizational learning strategy 282
organizational procedures 117
organizational proximity 54, 80, 105, 106, 108, 117, 261, 371
organizational structures 29, 30, 31, 32, 36, 97, 160, 405
organizational thickness 144
organizational thinness 145, 148, 278–9, 280
organized proximity 105, 113
Orsenigo, L. 32, 34
Ortega-ArGilés, R. 19, 433
Oslo Manual 437
Ottaviano, G.I.P. 386
Oughton, E. 358
outward knowledge spillovers 39
overlapping cultures 91
overlapping fields 94, 95
overlapping proximities 106, 262
Oxford Trust 343–4
Oxford University 339, 340, 344–5, 347
Oxfordshire 335, 340–46, 347
Oxfordshire BiotechNet 343
The Oxfordshire Innovation Engine 335, 344
Oxfordshire Investment Opportunity Network (OION) 343
Ozgen, C. 386, 391
Paris 70, 179, 180, 183, 232, 357
partnerships 24, 26, 81, 92, 108, 156, 157–8, 162–3, 260, 299, 334, 345, 364
Partridge, M.D. 428
Patel, P. 400
Patent Cooperation Treaty 389
patents/patenting 53, 435
gerographical localization of citations 48
gerography of knowledge spillovers 36
and level of innovative activity 177
as a measure of innovation 10, 438
metropolitan regions 68–77
migration and 386, 388–9
relatedness and knowledge 129, 131, 134, 136
slowing of imitation 35
path creation 57, 58, 143, 311, 313–16, 317
path dependence 56, 127, 128, 129, 135, 136, 158, 302, 311–12, 316–17
path destruction 311
path development 56–7, 151, 312, 314
path exhaustion 56, 57
path extension 56, 57, 284
‘path as process’ view 311–12
path renewal 56–7, 312, 377
Pavitt, K. 37, 161
Pearl River Delta (PRD) 323, 328
peer review 302
Penrose, E.G. 28, 111
perceived proximity 113
Perdue, P. 171
Peri, G. 386
peripheral areas/regions 277–90
characteristics 278–9
and the digital economy 366
economic development 81–4
increasing innovative activity 78–9
innovation in 2, 7, 67, 79–81, 82–3, 279–83
knowledge acquisition 145
overlooked in innovation studies 277
role of state in path development 314
systemic challenges 50
Perkins, S.J. 391
Perlmutter, H.V. 400
Perroux, F. 105
personal experience (geographers) 7–8
personal fields 94, 95, 96
personal networks 108, 256, 258, 259–60, 261, 364
Perugini, C. 425
Petralia, S. 136
Petrov, A. 2
physical capital 25, 26, 29, 64, 191
physical proximity 38, 64–6, 80, 105, 268, 363
Piketty, T. 419
Piore, M. 433
pipelines 2, 80, 83
pipelines policies 83
Pittsburgh 134
place, and innovation 1
place-based policy 129, 299–300, 302
place-based processes 5
place-dependence 129, 136
Plan for Intelligent Thessalonika 193
PlanIT Valley 194
planning
of intelligent places 192, 193–4, 197–8
urban cultural 266, 271, 272, 273
platform policies 55, 312
Plecher, M. 374, 375
Plum, O. 146
Plunket, A. 107, 110
Poland 231, 383, 384
Polèse, M. 428
policy see public policy
policy competences 48, 144
policy coordination failure 58
policy learning 7, 300, 305
Ponds, R. 101, 110
population density 181, 358
population growth 181–2, 428, 436
Porcheddu, D. 283
Porsche 282–3
Porter, M. 155, 243, 255
Portugal 194, 230, 231, 334, 389, 453
Potts, J. 203
poverty 425–9
Powell, W. 108
power 4, 172, 323, 447, 449
Prague 52, 357
Prahalad, C.K. 400
pre-existing capabilities 134
pre-existing knowledge 32, 111, 129, 134
Pred, A. 1
Preteceille, E. 454
Pries, L. 401
prioritization 302
process innovation(s) 24, 25, 27, 35, 56, 260, 303, 438, 440
process view, of regions 5
product diversification 111
product innovation(s) 10, 25, 27, 30, 56, 117, 177, 260, 303, 364, 375, 423
product space framework 130–31
production
IT-intensive 31
see also cultural production; global production networks; knowledge production
‘production function’ approach 25
‘production milieu’ approach 423
productive relationships 83
productivity
city size 174–5
emerging economies 323
firm-level 23–7, 29–30, 32
GPT-related 359
knowledge production 136
R&D and 22
productivity paradox 359
profitability 24, 29
project embeddedness 404, 406–8
property right 28, 401
see also intellectual property/rights
proximity 100–118
and innovation 1, 9, 243
and interactive learning 54
and knowledge networks 257
representations of 113–14
role of 261–2
studies
embeddedness and network modelling 107–12
exploring new avenues 112–17
issues and founding principles 104–7
stages in the development of 102–4
in urban milieus 244
see also cultural proximity; French School of Proximity; geographical proximity; physical proximity
proximity paradox 106, 261, 262
proximity/cognitive distance 106
Prucha, I.R. 26
public policy(ies)
knowledge sourcing and acquisition 151
local context 298, 301
urban cultural 266, 271, 272, 273
see also cluster policies; innovation policy(ies)
public spaces, as integrative places 453–4
Puga, D. 177, 221
Pune region (India) 52, 375
push-pull factors 159
Putnam, R.D. 361, 362
quantified narratives 108
Quebec 434, 439, 441
radical innovation(s) 2, 25, 50, 53, 55, 91, 142, 143, 151, 260, 284, 302
radical phase 165
Radosevic, S. 51
Rainie, W. 257
Rallet, A. 6, 10, 20, 103, 105
Ramlogan, R. 315
real proximity 113
recombination 46, 128, 129, 132, 136, 137, 268, 312
recruitment 145, 149, 150, 165, 282, 342
reflexive state 298
Regional Advantage 90
regional branching 311, 313
regional clusters 155, 156, 165
regional conditions 156–7, 165
regional context 337
regional development
endogenous economic growth 435–7
local innovation and 9–10
relatedness and 134
Regional Development Agencies (RDAs) 304–5
regional development policy(ies) 293, 294, 295
case studies 301–5
see also Medium to Long-term Policy (MLP); place-based policy
regional embeddedness 150, 402–5
regional growth 338–9
Regional Growth Fund 346
regional innovation
failure of EU policies 315
institutional dimension 292, 293–300
R&D and knowledge spillovers 22–40
theory meets practice through policy 300–305
regional innovation systems (RIS) 9, 45–58, 190, 196, 338
applications of approach to other contexts 51–2
clusters and 299
cultural embeddedness 88–97
evolution, China 322–32
geography of knowledge flows 53–4
global innovation networks 374
institutional views 309–10
knowledge bases 52–3
knowledge exchange 278
knowledge flows 155, 156
knowledge sourcing in synthetic sectors 147–8
OECD countries 295
origin and theoretical foundations 46–9
path dependence 311–12
policy 55–6, 309–18
conclusions 317–18
evolutionary view in path creation 313–16
implications of evolutionary approaches 312–13
path dependency and institutional change 316–17
recent research and research challenges 56–8
socio-institutional networks 66
types 49–51
see also thin RIS
regional knowledge structures 134
regional learning 196
Regional Liaison Office (Oxford) 345
regional networking 263
regional path development 56–7
regional policy 432
regional resource configurations 312
regional selection environment 313
regional stakeholder theory 339
Regional Studies 101, 103
’regional talent pools of global significance’ 181
regional triple helix model 336, 338, 339
regionalized national innovation systems 49–50
regionally networked innovation systems 49
regions 3, 4–6
knowledge spillovers 36
spatial configuration of GINs 373–4
see also cities-city regions; entrepreneurial regions; innovative regions; peripheral areas-regions; successful regions
REGPAT database 439–40
related industries 55–6
related variety 57, 128–9, 196, 278, 281, 302, 311, 312
relatedness 111, 116, 127–38
empirics of 134–7, 138
future research 137–8
geography of innovation 128–30
knowledge space 130–34
policies supporting 312
relational assets 310
relational contracts 304
relational proximity 108, 268
relationship maintenance 261
relationships
cooperative 81, 277
formal-informal 108, 163, 164, 256
inter-scalar 296–7
productive 80, 83
space-time 114–15
see also interpersonal relations/networks; knowledge relationships; social relations
relocation policies 294
remote areas/remote areas 2, 7, 10, 245–9, 432, 439, 441
research and development (R&D) 22, 46, 65
China 325
cooperation 146, 147
cultural diversity in employment 386
expenditures 25, 26
externalities 111
innovation and firm-level productivity 23–7
innovative activity 177
internationalization 370
investment 34
see also returns on investment
open innovation 91
relatedness 135
spillovers 111
research institutes 22, 36, 50, 64, 150, 175, 279, 323, 327
research laboratories 342
resilient city regions 178
Resnick, P. 362
resource availability 64
resource-based view of the firm 27–32, 33–4
resources 28, 336–7, 340–43
‘Return of the Swallows’ project 453
returnees’ direct contribution (migrant) 388
returns on investment 30, 34, 35, 37, 294

Revue d’Economie Régionale et Urbaine
100–101, 102, 104
Riddlesden, D. 358
Rigby, D. 132, 135, 136, 137
risk-taking 89, 91
Robin, S. 27
Rodriguez-Posé, A. 2, 19, 66, 68, 81, 82, 156, 164, 259, 260, 418, 425
Rogers, E. 1
Rohracher, H. 57
Romania 384
Romein, A. 423
Rothwell, J. 435
routines 28, 128, 311
rules 92, 93, 95–6, 160, 278, 293
Russia 228, 230, 231, 232, 236, 384
Rutten, R. 2, 362
Sabel, C. 433
St John’s Innovation Centre 343, 344
salaries, creative graduates 212, 215
sales growth 26
Salt Lake City 96
Salzburg 150, 151
Samsung 329, 330, 331
San Francisco 68, 69, 108, 183, 357
Sardinia 283
Sassen, S. 180, 229
Saxenian, A. 89, 90, 108
scale(s) 5–6, 10, 45, 293, 296–7, 361–2
see also economies of scale; multi-scalar perspective; spatial scales
Scellato, G. 389
Schaffers, H. 191
Schumpeter, J. 23, 24, 46, 128, 178, 183, 419
Schwarz, A. 224
science base, Oxfordshire and Cambridgeshire 342
Science Citation Index Expanded (SCIExp) 226, 230
science and engineering, migration and innovation 385–7
science policy 339
Science, Technology and Competitiveness (OECD) 46
Science Vale UK 346
Science-Technology-Innovation (STI) model 279, 280
scientific activities 223–37
beliefs critical mass 233–6
deconcentration of publications 229–33, 237
geocoding data for testing 225
Index 479

internationalization 235–7
spatial concentration of publications 227–8
geographical studies
emerging field 223–5
sources and methods 226–7
scientific change 128, 133
scientific competence 283
scientific knowledge 53, 138, 159, 224, 284, 295
scientific relatedness 111
Scott, A. 159–60, 182, 183, 229, 242, 243, 244–5
secrecy 36
sectoral relatedness 111
sectoral systems of innovation 54
sectorial culture 92
sectorial field 94, 95
seizing 29
sensing 29
Seoul 232
Serbia 384
seriality 342
service industries 30
Shanghai 69, 327
Shapin, S. 224
shared culture 91
shared geography 91
shared norms 48
shared vision 58
Shearmur, R. 2, 244, 418, 428, 434
Shenchao Technology Innovation Company 329
Shenzhen 327–31
SIENA model 109
similarity 105
Simon Bolivar Symphonic Orchestra 453
simultaneity 25, 114
Singapore 193, 231, 232, 322, 327
Singleton, A.D. 358
Sintef 283
skill transfer 392
skilled labour market 337, 346, 374
skilled workers
as an incentive to offshore and network 474
and firm innovation 32
high-tech industries and need for 31
and income 422
innovation and creativity in cities 176, 182, 183, 184
see also highly skilled migrants
skills 28, 29, 31, 295, 343, 422
see also digital technology skills
Skillset 203, 215
Slovakia 52
small and medium-sized cities 175, 177–8, 180, 184
small and medium-sized enterprises (SMEs)
10, 22, 82, 277, 278, 432
’small worlds’ research 109
small-scale innovations 10
smart cities see intelligent cities
smart specialization 301–2, 313, 316, 340
social capital 48, 92, 93, 256, 278–9, 280, 282, 284, 354, 361–5
social cohesion 447, 448–50, 452–5
see also cohesive cities
social contexts 47, 90, 142, 150, 159
social creation 448, 450, 455
social development 1, 447, 449, 452
social economy 455
social embeddedness 48, 107–9, 157, 175
social entrepreneurship 334
social hierarchies of a field 93
social innovation 274
social interactions 113–14, 270, 358
social learning 295, 300
social linkages 129
social networks 37, 38, 47–8, 92, 108, 180, 361
see also network analysis; online social networks
social proximity 54, 106, 108, 110, 142, 261, 371
social relations 108, 109, 160, 362
social ties 54, 358, 361, 362, 363, 365, 366, 388
socio-institutional networks 66
socio-territorial divides (urban) 449–50
socioeconomic implications, concentration of
innovation in cities 67–8
socioeconomic proximity 105
sociological view, of regions 5
sociology of practice (Bourdieu’s) 92–3
soft infrastructure 160
soft institutionalism 293, 296, 297, 301
software sector, graduate employment in 212
Solow, R.M. 359, 436
Sölvell, Ö. 400
South Africa 7, 231
South Korea 230, 231, 232, 237, 322, 329, 330, 387
South Ostrobothnia 148, 150, 151
South America 148
space in innovation processes 255–6
see also digital space; knowledge space; public spaces
space-time relationship 114–15
Spain 228, 230, 231, 232, 237, 316, 334, 384
spatial bias, social networks 47–8
spatial concentration
  of actors and firm innovation 1
  of innovation in cities 64–8, 78
  and interactive learning 1
  and lock-in 313
  of scientific publications 227–8
spatial dispersion 36, 39
spatial embeddedness 364
spatial heterogeneity 358, 360, 365
spatial intelligence 197
spatial knowledge 11
spatial ‘Other’ 269
spatial patterns, of innovation 68–77
spatial proximity 65, 105, 108, 113, 257, 261, 265
spatial scales 5, 114, 115, 125, 145, 347, 354
spatial taxonomy 4
spatial trends 10
specialization 64, 176, 177, 178, 179, 181, 209, 214, 313
see also smart specialization
specialized regions 50–51, 144–5
Spigel, B. 20
spillovers
  and distance 6
  R&D 111
see also knowledge spillovers;
  technology(ies), spillovers
spin-offs, entrepreneurial regions 338, 340, 342, 347
Srholec, M. 374
stable workforce 281
start-ups 108, 146, 149, 198, 259, 299, 335, 337, 338, 339, 341, 342
state role
  in emerging economies 322, 324
  path development 314
STEM workers 422
Stephan, P.E. 385, 386
stigma(tization) 454
Stokab 194
Storey, D. 337
Storper, M. 54, 181, 242, 437
strategic assets 28
strategic coupling 324, 327, 328, 329–30, 331
strategic decisions 94
strategic emerging industries (SEIs) 325–6, 327–31
strategic management 27–32
Streeck, W. 316
strong regional innovation systems 89
structural change analysis 49
structural indicators 116
Stuttgart 73

substitution mechanism 262, 263
suburban cultural workers 269–73
suburbs 2, 266
  creative 268–70
  networks of movement 246, 247, 248
  scholarly dismissal of 267
successful regions 10–11
Suire, R. 116
Sunley, P. 311–12, 313
supply chain management 31
surveys, as a measure of innovation 438
Sweden 2, 52, 78, 83, 149, 150–51, 194, 231, 376, 387, 419
Switzerland 231, 384, 387
symbolic capital 92, 93
symbolic knowledge 53, 55, 142, 143, 144, 145, 148, 151, 159–60, 268
symbolic sectors 148–9, 150–51, 160, 162, 164
synthetic knowledge 53, 55, 143, 144–5, 146, 148, 159, 268
synthetic sectors 147–8, 150, 151, 160, 162–3, 164
system failures (RIS) 55, 56, 57, 57–8
system perspective 47
system thinking, regional innovation 310
system-wide innovation 9–10, 11
systemic challenges (regional) 50–51
systemic innovation 187
tacit knowledge 27–8, 31, 32, 53, 143, 159
  acquisition 24
  appropriability 35
  clustering 196
  exchange 38, 66, 107, 268
  sharing 295
  spillovers 36
  stickiness 65, 371
  transfer 47, 54, 142, 155, 363, 365, 388, 391
Taiwan 230, 231, 232, 322, 328, 329
Talbot, D. 105
talent 149, 172, 175, 180, 181–3, 451
Tampere 148, 150, 151
Taylor, P. 229
TCL 329, 330, 331
tech-pole index 425
technical migrants 391
technoglobalism 353
technological advances 171, 214, 215
technological change 27, 31, 128, 129, 131, 133, 359, 421–2, 427–8
technological coherence 136
technological competition 27
technological diversification 111, 136
technological infrastructure 64
Index

481

technological innovation 25, 96, 314, 325, 441

technological knowledge 90, 129, 135–7, 138, 149, 256, 257, 259, 388

technological proximity 107, 111, 113

technological regimes 32–6

technological relatedness 132, 133, 134, 135, 312

technological resilience 136

technological systems of innovation 54

technological upgrading 322, 323, 324, 325, 327, 328, 329, 330, 331

technology(ies)

alliances 30

modifiers/adapters 25

smart specialization 302

spillovers 322, 325, 359

user needs and innovation 23–4

see also information and communications technology; new technology(ies)
technology transfer 24, 303, 337, 342

technology-driven firms 24–5

Teece, D.J. 24, 28, 29, 37

temporary proximity 115, 261
Ter Wal, A. 109

Ter Weel, B. 362

territorial anchoring 116–17

territorial embeddedness 1, 49, 371
territorial systems of innovation 187, 189–90, 191, 196, 323
territorial value-creation 2
territorialized innovation policies 105
territory 5, 7, 104

Texas 183, 250–51

Thelen, K. 316

theoretical predictions 2, 67, 76, 81
thick RIS 57

Thin Film Transistor Liquid Crystal Display (TFT-LCD) industry 329–31

thin RIS 57, 147, 148, 150, 278, 280, 281

Thompson Reuters 230

Thomson, S. 234

three-stage process model 338

time 6, 177
time geography 47
time-sensitive knowledge 11
timing of research 12

Tobler, W. 363

Tödtling, F. 52, 54, 81, 125, 374

Tokyo 74, 179, 180, 183
top management teams (TMT) 391

top-down governance 292, 294

Toronto 69, 108, 180, 269

Torre, A. 101, 103

Touburg, J. 391

Townsend, A.M. 357

Trade Related Intellectual Property (TRIPS) agreements 383

traded interdependencies 51, 54

traded linkages 54

traditional inputs 29

training 30, 31–2

Tranos, E. 354, 359, 360

transaction cost reduction 106, 362

transformation of RIS 58

transformational culture 300

transformative failures 56, 57–8

transitional mobility 115

transnational corporations (TNCs) 323, 324, 325, 327, 328

transportation systems (intelligent) 196

transversality 312

Treado, C.D. 134

Trip, J. 423

Trippl, M. 19, 52, 57, 125, 338

Tromsoe 281

trust 38, 48, 66, 157, 278, 361, 362

Turi, P. 363, 365

Turkey 228, 231

Twitter 358

Ukraine 384

unemployment 206–7, 294, 428

unfair cities 449

United Kingdom 2, 50, 69, 339, 358
career patterns, digital technology graduates 202–16

innovation

local consequences 419, 423, 424, 427–8

migration and 383, 384, 387

science activities 228, 230, 231, 232, 237

see also Cambridgeshire; London;

Oxfordshire

United States 7, 27, 30, 36, 47, 50, 68, 78, 198, 260, 357, 360

innovation

and creativity in city regions 69–70, 179, 183, 184

global networks (GINs) 373

local consequences 419, 422, 425, 426, 428

migration and 382, 383, 384, 385–6, 387, 388, 389, 393

relatedness and the geography of 136, 137, 138

regional economic development 294, 302–4

regions 4

science activities 228, 230, 231, 232, 236, 237

suburbia 269

see also individual cities and states

universities 22, 32, 34, 36, 47, 50, 64, 90, 150, 180, 327, 335–6, 337
see also Cambridge University; Oxford University
untraded interdependencies 51, 54, 196, 300, 362
untraded linkages 54
urban bias 3, 63, 69, 73, 78, 244, 438
urban cultural policy and planning 266, 271, 272, 273
urban development agreements 304, 305
urban diversity 2, 268
urban economics 22, 23, 37, 178
Urban and Regional Research Center (Utrecht) 109
urbanization 67, 277, 358
user needs, technology and innovation 23–4
Uyarra, E. 289, 314, 315, 318

Valdaliso, J.M. 316
Valencia 334
value chains 159, 164, 296
see also global value chains
value creation 2, 24, 156
values 48, 310
Van Der Wouden, F. 136
Van Hoven, B. 391
Van Pottelsbergh de la Potterie 27
Vancouver 69, 269, 305
Vega, M. 400
Veltz, P. 229
vertical networks 48
Vicente, J. 116
video game sector 109–10, 116–17
Vienna 146–7, 148–9, 150–51, 357

violations, rules of a field 93
virtual mobility 394
vision 58, 338–9, 343–5

Wacquant, L.J. 361
wage distribution 422
Wagner, C. 235
Walker, R. 437
Walkerstein, I. 224
Washington 69, 70, 357
Wattiaux, J.P. 390
weak economic fabrics 67
weak ties 362, 363
Web 2.0 technology 361
Weber, K.M. 57
Weinstein, A.L. 428
Weitzman, M.L. 128
Wellman, B. 108, 257
Westlund, H. 282, 334, 347, 362
What Works Centre for Local Economic Growth 360
‘whole-of-city thinking’ 272
Wilkie, C. 19
winning areas 447, 449–50
Winter, S.G. 24, 311
Wolfe, D.A. 171, 172
Wolfson Industrial Liaison Unit (WILO) 342
world first innovations 10
Wyrwich, M. 334

Yang, C. 7, 289
Zizalova, P. 52