Innovation and Entrepreneurship in the Global Economy

Knowledge, Technology and Internationalization

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New Horizons in Regional Science
Contents

List of contributors vii
Preface ix

Introduction 1
Charlie Karlsson, Urban Gråsjö and Sofia Wixe

PART I INNOVATION

1 R&D investments and firm survival across regions 21
Maria Jesús Abellán Madrid, Antonio García-Tabuenca and Cristina Suárez Gálvez

2 Universities and public research institutes as collaboration partners for firms 44
Anders Broström and Maureen McKelvey

3 Technological advancement through imitation by industry incumbents in strategic alliances 65
Nerine Mary George, Sergey Anokhin, Vinit Parida and Joakim Wincent

4 Continuing corporate growth and inter-organizational collaboration of international new ventures in Sweden 89
Jan Abrahamsson, Håkan Boter and Vladimir Vanyushyn

5 Routines: do they stimulate or hinder learning and innovation in industrial production? 117
Knut Ingar Westeren

PART II ENTREPRENEURSHIP

6 Creativity spillover of entrepreneurship: evidence from European cities 141
David B. Audretsch and Maksim Belitski
Innovation and entrepreneurship in the global economy

7 Start-up rates, entrepreneurship culture and the business cycle: Swedish patterns from national and regional data
Martin Andersson 162

8 Immigrant entrepreneurship and agglomeration in high-tech industries in the USA
Cathy Yang Liu, Gary Painter and Qingfang Wang 184

9 Broadband Internet and new firm formation: a US perspective
Jitendra Parajuli and Kingsley E. Haynes 210

10 When being wrong might be right: on overconfidence as an evolutionary mechanism of nascent entrepreneurs
Martin G.A. Svensson 237

PART III INTERNATIONALIZATION

11 Manufacturing renaissance: return of manufacturing to western countries
Sam Tavassoli, Babak Kianian and Tobias C. Larsson 261

12 Closing the gap: empirical evidence on firms’ innovation, productivity and exports
Viroj Jienwatcharamongkhol and Sam Tavassoli 281

13 Infrastructure endowment, social capital and outsourcing: evidence from Emilia Romagna, Italy
Roberto Antonietti, Maria Rosaria Ferrante and Riccardo Leoncini 310

Index 331
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Preface

This anthology consists of revised papers, first presented and discussed at the 16th Uddevalla Symposium (www.symposium.hv.se) on ‘Innovation, High-Growth Entrepreneurship and Regional Development’, hosted by Ewing Marion Kauffman Foundation, Kansas City, MO, USA, 13–15 June 2013. The objective of the symposium was to provide a unique opportunity for scholars, including senior and junior researchers, to discuss path-breaking concepts, ideas, frameworks and theories in plenary keynote sessions and parallel competitive paper sessions. A selection of the papers presented at the symposium is included in this book. Each paper has gone through a careful referee process.

The 16th Uddevalla symposium was organized by University West, Sweden in cooperation with three US institutions: the Institute for Development Strategies, Indiana University, Bloomington, IN, the Kauffman Foundation Institute, Kansas City, MO, George Mason University, VA; and four Swedish research centres: the Centre of Excellence for Science and Innovations Studies (CESIS), Royal Institute of Technology, Stockholm, and Jönköping International Business School, Jönköping, the Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE), Lund University, the Center for Inter-Organisational Innovation Research (CiIR), Luleå University of Technology, Luleå, and Umeå University, Umeå, and the Centre for Entrepreneurship and Spatial Economics (CEnSE), Jönköping International Business School, Jönköping. We thank all the above institutions for their contributions to the organizing and financing of the 16th Uddevalla Symposium, as well as Dr Irene Bernhard and Ms Rebecca Olsson for their excellent work in the planning and practical implementation of the 2013 Uddevalla Symposium.

Charlie Karlsson, Urban Gråsjö and Sofia Wixe
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Introduction

Charlie Karlsson, Urban Gråsjö and Sofia Wixe

In recent decades we have been able to witness a veritable revolution in the world economy, with dramatic changes in the competitiveness of nations, regions and companies. The most commonly used term to describe this revolution has been ‘globalization’, even if there is no common definition of this term in the literature. In fact, all definitions of globalization are elusive and elicit criticism (Thurik et al., 2013). Generally, the term is connected with the rapid increase in the free movement of goods, capital, people, ideas, information and knowledge around the globe. The shift of economic activities between regions in different national spheres ranks among the most vigorous changes shaping the economic landscape of today (Dreher et al., 2008).

Much of the discussion about globalization has been held at a rather superficial macroeconomic level. Discussions at the meso- and microeconomic level, that is, the level of regions and companies, have been much less common, and many have also been biased in the sense that they have only given a partial picture. One obvious example is that discussions on the role of innovation and entrepreneurship have tended to use a narrow definition of entrepreneurship as the start-up of new companies; as a result they have ignored the high degree of innovation and entrepreneurship within many incumbent companies. This is problematic, since innovation and entrepreneurship, generating new technologies, new products and new production processes, are at the core of economic development and growth (Hall, 1999).

The purpose of this book is to contribute to the meso- and microeconomic literature on innovation and entrepreneurship in the global economy.

1. GLOBALIZATION

There is a tendency in the current literature to treat globalization as a new phenomenon that started to emerge in the postwar period. This can
certainly be questioned (Kenwood and Lougheed, 1999; Taylor, 2002; Karlsson et al., 2010) but is of lesser importance here since we focus on the current wave of globalization. Some authors claim that it was the break-up of the Soviet Union and the Warsaw Pact, highlighted by the fall of the Berlin Wall, possibly together with the changes in China towards a more market-oriented economy, that kicked off the current wave of globalization (Thurow, 2002). However, these important historical events did not start the current wave of globalization but gave it substantially more energy by opening up ‘fertile land’ for the globalization efforts.

The original motor behind the current wave of globalization was the drive among large manufacturing companies, which, via foreign direct investment (FDI) on top of their export efforts, wanted to get control over raw material sources as well as increase their sales. By moving production to other countries, it was possible to overcome tariffs and other trade impediments and at the same time adapt their goods to customers’ preferences and willingness to pay in these countries. These firms represent the managed economy, where economic performance is positively related to firm size, scale economies and routinized production and innovation (Thurik et al., 2013).

In recent decades, this motor has been complemented by a second, which we can call the ‘entrepreneurship motor’, representing the wave of new firm formation and growth coming from new technological fields such as microelectronics, software and bio-technology (cf. Koellinger and Thurik, 2012). These firms represent the entrepreneurial economy, where economic performance is related to distributed innovation and the emergence and growth of entrepreneurial ventures (Audretsch and Thurik, 2001). Entrepreneurship in the sense of new firm formation is of course critical, since it fosters competition, inducing innovation and the emergence of new industries (Dejardin, 2011). Over the years many processes have contributed to stimulate globalization and to shift the comparative advantages for different types of economic activities between countries, making it possible and even essential to locate many new capital investments, that is, factories, plants and establishments, to low-cost locations outside the USA and Western Europe (Audretsch, 2010). These processes (in no particular order) include:

- The reduction of tariffs and trade barriers, first via GATT and later via WTO
- The creation and enlargement of the EU and the creation of NAFTA and other free trade blocs
- The establishment of a global air travel network
• The rapid expansion of highway networks, increasing the reliability of truck transport
• The rapid growth of container transport
• The deregulation of many markets, in particular financial markets
• The emergence of global financial markets with large and rapid flows of capital between different global financial centres
• The establishment of global technological standards
• The information and communications technology (ICT) revolution and the establishment of the Internet and a much more rapid diffusion of large volumes of standardized information (Castells, 1996)
• The emergence of global just-in-time media coverage (Karlsson and Picard, 2011)
• The emergence of a global knowledge economy via
  – rapidly increasing investments in knowledge production, that is, in particular, R&D, with important breakthroughs in many research fields, not least related to microelectronics, and
  – rapidly increasing investments in higher education in an increasing number of countries
• Substantial increases in international migration, in particular among highly educated groups of people
• Increasing real incomes resulting in larger demand for diversity in consumption
• An increasing number of people in the world who have emerged from poverty
• The introduction of new computerized design and production methods, which has increased flexibility in production and allowed for more or less instant shifts between models produced to meet rapidly shifting demand among customers with a taste for diversity
• New methods to organize production with more flat organizations using ICT solutions and external suppliers via outsourcing and offshoring to gain lower costs by taking advantage of suppliers’ internal scale economies
• A rapid increase of intra-industry trade to take advantage of internal economies of scale in production
• A rapid increase in the number of multinational firms (MNFs) and in the number of MNF affiliates.

The above list clearly illustrates that the current wave of globalization has been intimately connected with an overwhelming number of product, process, input and organizational innovations, clearly illustrating that it
has also been a period of exceptional entrepreneurship, among both large MNFs and independent entrepreneurs. However, creativity, innovation and entrepreneurship have not been present everywhere. On the contrary, they have been strongly concentrated in a limited number of large urban regions in the richer countries in the world (Montgomery, 2008; Florida, 2009), even if they can and do occur in non-urban economic milieux (Shearmur, 2012).

2. INNOVATION, ENTREPRENEURSHIP AND LARGE URBAN REGIONS

Despite all the claims about ‘the death of distance’ or that ‘the world is flat’, it becomes more and more obvious that location matters for creativity, innovation and entrepreneurship, and, in particular, location in large urban regions. Why is this the case? What do large urban regions offer that is so critical for creative, innovative and entrepreneurial activities? One factor is concentrations of organizations, such as research universities and R&D labs, that are direct or indirect generators of innovation and entrepreneurship (Acs, 2002). Another factor is that creative, innovative and entrepreneurial people are attracted to large diversified cities (Florida, 2002; Landry, 2008) and that companies that locate in such regions tend to be more innovative and entrepreneurial, either through learning or through sorting; that is, companies draw on, or adapt to, their regional environment (Doloreux, 2005).

Even if it is widely accepted that the internal capacities and activities in companies are critical for their innovative and entrepreneurial capacity (Lichtenhaler and Lichtenhaler, 2009), it is also widely recognized that a primary factor affecting a company’s innovative and entrepreneurial capacity is its openness to external sources of information, knowledge and collaboration. Large urban regions are information-, knowledge- and contact-rich economic milieux both in intra- and interregional terms, since they are built up not only by innumerable interconnected networks but also by nodes connected to other large urban regions in a space of information and knowledge flows (Castells, 1996). Hence it is optimal for innovative and entrepreneurial companies to locate in such regions to maximize their chances of obtaining appropriate information and knowledge, of identifying opportunities, and of finding suppliers, collaborators and clients (Sedgley and Elmslie, 2011). These regions also offer the best conditions for potential entrepreneurs to become actual entrepreneurs.

It costs more for a company to be located in a large urban region, and it is only those companies whose innovation capability requires intense and
frequent interactions with other economic agents that will pay the extra costs for such a location (McCann, 2007). These companies usually deal with the most knowledge-dependent and uncertain innovations, and rely on trial and error and close cooperation with customers and/or suppliers (cf. Duranton and Puga, 2001). These general conclusions do not preclude that, in some industries, companies may avoid industry clusters in cases where the risk for regional knowledge spillovers to competitors is very high (Suarez-Villa and Walrod, 1997). However, innovations developed outside the large urban regions normally only reach their full commercial potential if they are introduced, further developed, and marketed in a large urban region. Altogether this points in the direction that large urban regions are the loci of innovation and entrepreneurship because economic agents with social and market power to promote them tend to reside and have their activities there (Yeung, 2005).

The critical role of large urban regions depends on companies and entrepreneurs innovating in an open fashion; that is, they rely on face-to-face interaction with other economic agents, which is greatly facilitated by the economic milieu offered by large urban regions due to their greater physical proximity (Storper and Venables, 2004). The much richer options for face-to-face interaction in these areas are important not only because the transfer of complex, uncertain and partly tacit knowledge often needs repeated face-to-face interactions, but also because such options open up more chances for unscheduled or serendipitous encounters – those most likely to result in the juxtaposition of different types of information and knowledge, which through creative processes might lead to innovations and new entrepreneurial actions (Godoe, 2012). Boschma (2005) remarks that there are other types of proximity that are important for creativity, innovation and entrepreneurship. They include social proximity (e.g. friendship ties), organizational proximity (e.g. working for the same company or company group), cognitive proximity (e.g. having the same knowledge base) and ‘institutional’ proximity (e.g. working in the same type of organization, such as a university). One might very well also add occupational proximity, that is, having the same type of occupation; and supplier–customer proximity in terms of types and frequencies of delivery. However, Boschma omits to note that the strength of all these different proximities is a function of geographical proximity.

Thus large urban regions are conducive to creative, innovative and entrepreneurial processes, and this claim is supported by various types of empirical evidence. They generate more patents per capita than smaller regions (Bettancourt et al., 2007), are the location where world-first new products and radical innovations are introduced (Audretsch and Feldman, 1996), and are where new industries emerge (Duranton and
Innovation and entrepreneurship in the global economy

Puga, 2001). Against this background it is obvious that large urban regions and creativity, innovation and entrepreneurship are intrinsically interlinked in numerous ways. Thus urban regions tend to evolve in a path-dependent fashion (Neffke et al., 2011), based on the internal and external information, knowledge and contact links they offer. This implies that most of the innovations and the entrepreneurship that emerges in such regions are related to historical industrial structure and knowledge supply.

There is a long-standing controversy concerning what type of urban region provides the most fertile ground for innovation and entrepreneurship (cf. Glaeser et al., 1992). According to the so-called Marshall–Arrow–Romer (MAR) model, it is the concentration of a particular industry within a specific urban region that promotes intraregional knowledge spillovers across economic agents, stimulating innovation and entrepreneurship in that region and within that particular industry. Research on cluster dynamics stresses the importance for innovation of interactions of companies in the same industry (Wolfe, 2009). According to this perspective, companies in the same industry have similar infrastructure needs, labour forces, suppliers and markets. It is assumed that such localization economies, combined with knowledge spillovers, provide the preconditions for innovation and entrepreneurship.

Jacobs (1969) presented an alternative hypothesis that the general agglomeration of companies in urban regions fosters innovation and entrepreneurship due to the diversity, variety and complementarity of the knowledge sources located in the region (Desrochers, 2001). Here it is chance encounters and the combination of knowledge from unexpected sources that enhance innovation and entrepreneurship. However, it is not only the diversity of economic actors and the knowledge base, but increasingly the diversity of the ethnic, cultural and social fabric that is seen as a prerequisite for creativity, innovation and entrepreneurship (Niebuhr, 2009). Thus it seems clear that however entrepreneurs and companies draw on their external economic milieu to innovate and to be entrepreneurial, this milieu is richer, more knowledge-intensive, more diverse and more highly specialized in all dimensions in large urban regions than in non-urban regions (Glaeser, 2011). We must also remember that there are probably optimal levels of diversity or heterogeneity (Fujita, 2009), and that, over time, heterogeneity might lead to homogeneity in the absence of stochastic processes stimulating heterogeneity.

Despite many empirical studies that have tried to solve this controversy, no definitive answer has yet been presented. Perhaps other underlying factors determine which type of knowledge spillover is most important in different urban regions. It is rather unlikely that one single process would prevail (Iammarino, 2011). Depending on differences in historical
trajectories, existing industrial specialization and knowledge base, external pressures and public policies, we can imagine that it is possible to identify a number of different typical development paths for urban regions.

Another related controversy circles around the question of whether it is weak or strong regional competition that is more conducive to innovation and entrepreneurship in an urban region. According to the MAR model, weak regional competition is superior to strong regional competition since it enhances the ability of companies and entrepreneurs to appropriate the economic value of their innovative and entrepreneurial activities. Porter (1990), on the other hand, maintains that competition is more conducive to innovative and entrepreneurial activities.

One might claim that the above discussion suffers from a basic static bias. It tends to neglect that the life-cycle stage within which an industry is operating contains answers to questions such as who are the innovators and the entrepreneurs, how much innovative and entrepreneurial activity is undertaken and where do the innovative and entrepreneurial activities take place (cf. Klepper, 1992). It also neglects that decisions on organizational factors within companies such as vertical integration and choices on innovation and location are strategic decisions and thus evolve as markets, technologies and politics change (Chandler et al., 1999). Within such a context, the location of innovative and entrepreneurial activities is determined by accessibility to the necessary market and input conditions, including accessibility to the necessary knowledge inputs, not least via intra- and interregional knowledge spillovers. The industry life cycle is often described as consisting of the following stages (Williamson, 1975):

- In the first, early formative innovative and entrepreneurial stage, it is typical that the supply of a new product normally comes from different producers offering different but varying and rather primitive designs using highly skilled workers and comparatively unspecialized machinery. This takes place in one nursery city or a limited number of nursery cities (Duranton and Puga, 2001) in one country and sold in small quantities to advanced and demanding customers mainly located in large urban regions in the home country. The business experience during this stage is characterized by a high degree of uncertainty and, typically, many of the early entrepreneurs fail for various reasons.

- The second, intermediate development stage is characterized by the emergence of a dominant design, the use of more refined manufacturing techniques, a rapid increase in output from remaining companies as new applications are recognized and unsatisfied demand increases, since the new product has proven its value for larger
groups of customers. Uncertainties concerning products, production processes, markets and competitors are now reduced, and, to take advantage of existing internal economies of scale, companies now increasingly try to serve foreign markets by means of exports.

- The third, mature stage, with fully standardized products and production processes, is characterized by an advanced refinement of production, marketing and management techniques, and increased focus on cost control while serving growing markets. Radical innovations are scarce and most innovations take the form of marginal improvements. New large-scale integrated production facilities are now established in the hinterland of large cities with a strong logistics position, in low-cost locations in more peripheral locations in the own country (Rees, 1979), and close to the market in foreign countries by means of FDI (Vernon, 1966). Various efforts are made to ‘bind’ customers to their current supplier to fend off major competitors.

Due to the introduction of computerized flexible production systems, rapid improvements in information and communication technologies, and improvements in transport networks, it is possible to identify a fourth stage of knowledge-based fragmentation and differentiation. This stage opened up new options in market economies and increased the number of options open to companies.

It became possible, not least for the large multinational companies, to fragment the different production steps, locate them in the region offering the best conditions and maintain control of their global production networks² (Coe et al., 2008) via network control (Warda, 2013). These companies could introduce new business models (Brynjolfsson and Hitt, 2000), scale down their large inflexible production facilities and, in a systematic manner, start to outsource and even offshore production stages. Newly established companies could avoid investing in large-scale integrated production facilities and take advantage of outsourcing and offshoring from the very beginning. This outsourcing and offshoring manifested itself in the form of outward FDI from the developed countries (Friedman, 2005). By outsourcing/offshoring the production of parts and subsystems, companies can lower their costs, since they can take advantage of suppliers’ location cost advantages and internal economies of scale – scale economies that they cannot achieve themselves with in-house production due to too small production series. However, outsourcing/offshoring is not limited to various types of inputs and services. Increasingly companies outsource R&D to take advantage of unique knowledge in specialized companies and offshore R&D activities to those large urban regions where competitors...
have located their R&D and/or where leading research universities do high-quality R&D of special interest to the company. This reorganization of large companies opened up opportunities for spin-offs and new roles for small entrepreneurial firms (Klepper and Thompson, 2010).

Another major advantage for companies of the radical new way to organize and control production is that it is much easier to produce differentiated outputs to meet customers’ demand for variety, as well as differences among customers in their capacity and willingness to pay for different product attributes. Customers’ demand for variety also makes it possible for new entrepreneurs to enter the market to serve distinct small groups of customers with specific product varieties.

If we summarize the above discussion, we see that we can identify two main groups of actors in the marketplace behind the ongoing transformations. On the one hand, we have a large and increasing number of multinational firms that use all the options opened up by the current wave of globalization and by the many important accompanying technological changes. They have reorganized their production chains by means of outsourcing and offshoring parts of their production to lower-cost locations, often in other countries, which have generally preserved the viability of many of these multinational firms (Audretsch and Thurik, 1999). The result has often been a substantial downsizing in terms of total employment, but a shift to a substantially higher share of highly skilled employees, resulting in a divergence of unemployment rates between high-skilled and low-skilled workers (Mankiew and Swagel, 2006).

On the other hand, we have a myriad of entrepreneurs who have launched their new businesses and often failed; however, a limited number have succeeded, often by launching radical innovations that have created totally new industries and changed the way we organize production and do business, including the outsourcing and offshoring of non-core business activities (EIM, 2009). This ‘entrepreneurial revolution’ has been stimulated partly by corporate reorganization leading to new organizational structures in large as well as small and medium-sized firms, and partly by greater emphasis on knowledge as a production factor, opening up new opportunities for spin-offs and new roles for small and medium-sized firms (Klepper and Thompson, 2010). However, higher real income levels have also opened up new entrepreneurial opportunities by leading to a more service-oriented economy (Bryson et al., 1997), differentiation in consumer demand (Piore and Sabel, 1984), and a shift in occupational preferences (Uhlmaner and Thurik, 2007). To stay competitive in this ‘new knowledge economy’, small and medium-sized firms have increased their spending on R&D and thus increased their share of total private R&D (Mowery, 2009).
It is of interest that much of the recent globalization literature has mostly concentrated on one of these processes, without acknowledging the existence of two very strong parallel processes that, in a couple of decades, have transformed both the structure and the location of the private sector within as well as between countries. As globalization spreads, employment tends to stop increasing and often even starts to decrease in general, with incumbent, mainly multinational, firms generating entrepreneurial opportunities for new firms and for existing small and medium-sized ones (Thurik et al., 2013). It is often not noticed that some of today’s larger multinational companies were founded by entrepreneurs a decade or a few decades ago.

3. POLICY RESPONSE TO GLOBALIZATION

Against this background, which is the proper policy response to globalization and its very distinct effects? The public policy debate has increasingly come to stress knowledge and ideas as the source of competitiveness and economic growth. This policy focus is supported in the economics literature, where knowledge and ideas have emerged as critical growth factors in the new endogenous growth theory (Lucas, 1988; Romer, 1990). The endogenous growth theory assumes that knowledge has the character of a public good, and that an entire economy automatically benefits from its investments in R&D and education through spillovers. In particular, it is the possibility that more than one firm or economic agent can use a certain piece of knowledge that is particularly conducive to economic growth. Although there is, of course, a great deal of evidence that access to knowledge (R&D stock and human capital) leads to economic growth, some countries seem to benefit more from investments in knowledge than others.

National governments have also begun vigorous and targeted efforts to spur the start-up and growth of new firms, that is, through entrepreneurship policies (Karlsson and Andersson, 2009). An important implication of the current wave of globalization is that focusing on entrepreneurship policies ignores the pervasiveness and the prevalence of the underlying forces. Promoting new firm formation and/or post-entry performance is too narrow an interpretation of the appropriate public policy response. Rather than developing an entrepreneurship policy, the appropriate policy response is to develop policy for an economy where large multinational firms coexist with vibrant entrepreneurial firms, and where firms of different sizes increasingly cooperate via outsourcing and offshoring.

The impact of technological change and its many mediators on all
types of firms is so complex and so pervasive that the policy implications go beyond creating an entrepreneurship policy to support other public policy avenues. Rather than a narrow focus on promoting new firm formation and/or growth of new firms, the appropriate policy response is to re-engineer the public policy response in a broad and pervasive sense and develop policies for a dynamic, self-renewing market economy with a sound mix of small and medium-sized firms, as well as large multinational firms in which entrepreneurship plays a key role (Acs, 2006). This implies the formation of formal institutions that, for example, reduce the barriers and costs of entry and growth of firms, facilitate the sectoral and spatial mobility of resources, in particular labour and capital, stimulate investments in R&D and education, and increase the openness of the national economy for international competition (cf. Kirchoff, 1994).

However, increased sensitivity among companies to the location conditions offered in different regions has changed the public policy arena. The ability of national governments to control the behaviour of companies has been reduced not least due to deregulation over broad sectors. International competition is becoming less of a competition between nations and increasingly a competition between regions, where the options for many regions due to lack of resources are often quite limited. Poor regions’ main competitive advantage is low costs, given that they do not exploit a rich source of unique raw materials. Large and rich urban regions, on the other hand, have many options to compete, with superior material infrastructure, good housing infrastructure with plenty of amenities, a well-educated labour force and high-quality universities. What limits the actions of large and rich urban regions is the lack of regional government; national government controls many critical areas such as transport infrastructure, higher education and public financing of R&D. In any case, the large and rich urban regions will mostly keep their position as hotspots for innovation and entrepreneurship for a substantial time.

For researchers, the current wave of globalization offers innumerable interesting and important research questions. A few of these research questions are highlighted in this book, but, as always, researchers normally ask more questions than they answer in their papers. The chapters in this book are no exception to this, but at the same time they contribute significantly to an increased understanding of innovation and entrepreneurship in a global world.
4. THE CONTENTS OF THIS BOOK

Below we briefly summarize the contributions in the sequence in which they appear in the book so that the reader can plan for the reading experience.

In Chapter 1, Abellán Madrid, García-Tabuenca and Suárez Gálvez explore the relationship between R&D and firm survival using a sample of Spanish manufacturing firms. The results show a positive relationship between R&D expenditure and survival probability, with differences depending on the environment. The authors define the different environments as combinations of technological regions and sectors.

How firms assess the value of R&D partnerships with public research institutes and universities is examined by Broström and McKelvey in Chapter 2. Survey data on Swedish manufacturing firms suggest that contact with universities gives firms greater impulses to innovation and offers more opportunities to learn than contact with public research institutes. However, this difference is valid only for firms applying for patents. Furthermore, the view of public research institutes as more oriented towards applied R&D than universities cannot be verified. The authors conclude that, in terms of perceived effects of R&D managers, public research institutes and universities are more similar as collaboration partners than might be expected.

The conventional wisdom that industry front-runners are most likely to experience high rates of technological advancement in strategic alliances is challenged in Chapter 3 by Mary George, Anokhin, Parida and Wincent. Instead, the authors suggest that imitation and not innovation is the primary source of such advancement. Empirical evidence from a sample of over 150 incumbents with varying degrees of technological progress suggests that lagging established corporations prefer to imitate start-ups and not fellow incumbents.

In Chapter 4, Abrahamsson, Boter and Vanyushyn examine the scope and pattern of inter-organizational collaboration of international new ventures. Their findings suggest that international new ventures are very likely to be involved in international cooperation and to have a broader scope of international partnerships, in terms of both number of partners and their geographic location.

Whether routines stimulate or hinder learning and innovation in industrial production is the question in focus in Chapter 5 by Westeren. The author discusses how definitions of the concept of routines have advanced, and the different characteristics that can be linked to the concept. An empirical example is presented in which Westeren discusses how learning and innovations can be seen in relation to creation, maintenance and changes in routines.
Compelling evidence based on data from European cities of the indirect effect of human capital and creative capital on urban economic development is delivered in Chapter 6 by Audretsch and Belitski. The authors develop the basis of the creativity spillover of entrepreneurship theory and introduce a novel concept of ‘creativity filter’. They confirm that the availability of creative capital does not *per se* result in economic development, as found in previous studies. Exchange of ideas and new firm start-ups are needed to facilitate the spillover and commercialization of those ideas, and to minimize the size of the ‘creativity filter’.

It is often claimed that locally embedded values and attitudes towards entrepreneurial activity exert a strong influence on the rate and level of entrepreneurial activity in regions. The concept of regional entrepreneurship culture aims to capture such phenomena, and refers in a general sense to the level of social acceptance and encouragement of entrepreneurs and their activities in a region. In Chapter 7, Andersson discusses regional entrepreneurship culture as a source of persistent differences in regional rates of new firm formation, and presents a number of empirical regularities for Sweden to illustrate the empirical relevance of the main arguments. Using data on rates of new firm formation across Swedish regions over time, the author further explores the association between start-up activity and the business cycle, as well as how the geographic distribution of start-up rates changes during a major economic crisis.

In Chapter 8, Liu, Painter and Wang examine the characteristics and spatial patterns of immigrant entrepreneurship in high-tech industries in the USA. They find that supporting industries such as professionals, management and other producer services are very important for immigrant high-tech businesses. Also, higher ethnic diversity and a larger share of the foreign-born population are crucial factors in attracting or fostering high-tech entrepreneurship.

Broadband Internet is considered an important determinant of economic growth and development. The relationship between broadband infrastructure and new firm formation in the USA is investigated by Parajuli and Haynes in Chapter 9. The findings show that single-unit firm births and the provision of broadband are positively related across almost all industry sectors in the USA. However, the impact of broadband provisioning on new firm formation is sensitive to agglomeration and aggregate sectoral patterns of states and economic sectors.

In Chapter 10, Svensson highlights the role of cognitive bias as a reinforcing mechanism that facilitates start-ups but downplays survival of firms at the neighbourhood level. The author emphasizes entrepreneurs’ cognitive biases, as shallow processing causes overweight of unlikely conditions and thereby lower risk perceptions, making firm formation more
likely. As a consequence of such processing, entrepreneurs also become more responsive to discrete representations of those who have started or are about to start their own business (entrepreneurial role models).

Recent observations show that the location of manufacturing is gradually shifting to western countries again. This argument is put forward in Chapter 11 by Tavassoli, Kianian and Larsson. The authors use the product life-cycle model in order to demonstrate how location of manufacturing shifts to the West, a trend especially pronounced in the USA.

In Chapter 12, Jienwatcharamongkhol and Tavassoli investigate the relationship between productivity and export behaviour of firms. More specifically, the authors study the link from innovation input to innovation output to productivity and exports. The findings indicate that export behaviour of firms can be explained by the productivity of those firms that have succeeded in adopting innovation output in the past.

Whether social capital and infrastructure endowment have a positive impact on the propensity to fully or partially outsource production is examined by Antonietti, Ferrante and Leoncini in Chapter 13. They find that the local level of social capital increases the probability of fully outsourcing production, and that this effect is more pronounced in regions with good infrastructure. However, no significant effect of social capital is found on partial outsourcing.

NOTES


2. Some authors use the parallel concepts ‘global commodity chains’ and ‘global value chains’ (Henderson et al., 2002).

REFERENCES


EIM (2009), *Small Firms and Subcontracting*, Zoetermeer: EIM/Panteia.


1. R&D investments and firm survival across regions

María Jesús Abellán Madrid,
Antonio García-Tabuenca and
Cristina Suárez Gálvez

1. INTRODUCTION

Expenditure on R&D has been gaining increasing attention over recent decades (Jaffe, 1986; Cohen and Levinthal, 1989; Griliches, 1998; and Lee, 2002). This has been reinforced by the rise of the ‘knowledge society’,\(^1\) which has positioned R&D expenditure as a positive externality requiring government support. Given the current crisis, the OECD (2010) has stressed that innovation – and R&D – is essential for countries and firms to recover from the economic downturn and thrive in today’s highly competitive and connected global economy.

In parallel, there has been a growing interest in the development of entrepreneurship and business dynamics through the behaviour of firms in different sectors and regional environments (Kirzner, 1973; Schultz, 1979; Audretsch and Thurik, 2004; Lazear, 2005; Parker, 2005; Klein and Cook, 2006; and Johannisson, 2009). The entrepreneurial activity has emerged as a key element in economic development (Acs et al., 2004; Thurik and Wennekers, 2004; Stel et al., 2005; Braunerhjelm, 2007; and Audretsch, 2007). Braunerhjelm (2011) has highlighted that there is an intricate nexus of interacting forces on four variables: entrepreneurship, knowledge, innovation and economic growth. Thus a large number of public programmes has tried to boost entrepreneurial development as a response to the economic crisis.

Therefore the set of policies simultaneously encouraging R&D and entrepreneurship raises the question of how they both relate and whether it is possible to find synergies between them, and also the extent to which R&D strengthens the likelihood of firm survival. A review of the literature on entrepreneurship demonstrates that there is a concern for finding its determining factors (Acs and Armington, 2004; Audretsch and...
Callejón, 2007). Moreover, the theory of knowledge spillovers explains how knowledge (mainly measured as R&D expenditure and patents registered) is a driving force for entrepreneurship (Acs et al., 2005). This theory also explains how the creation of a company is an endogenous response to investment in knowledge, which is not entirely appropriate for incumbent firms (Audretsch and Keilbach, 2011). Also, Carlsson (2011) has shown in a range of national innovation systems that ‘new knowledge’ is the driving force of innovation, entrepreneurship and economic development.

Referring to the case of the Spanish economy, the current crisis has significantly worsened these indicators of investment in knowledge. Until 2008, R&D rates continued to rise in line with the acceleration since 2004, with figures pointing to a certain convergence with European and other advanced countries of the OECD. In that year, this expenditure continued to increase by 7.6 per cent (in constant euros), while from 2009 it has decreased markedly. According to the National Statistics Institute (INE, 2012), in 2011, domestic expenditure on R&D recorded a decrease of 4.1 per cent compared to the previous year: business spending shrank by 5.4 per cent, while spending on public administration and higher education fell by 3.3 per cent. Also, staff dedicated to R&D recorded a significant decline. It is anticipated that this recent spending contraction in the Spanish economy will continue in coming years, resulting in a continuous deterioration (COTEC, 2012, p. 11).

In the field of patents registered, we can see an improvement in the Spanish economy, although the crisis has had negative impacts. However, providing a comparable measure should make the data accord with international scales. Concerning triadic patents (Europe, Japan and the USA), Spain shows limited ability to protect its innovative efforts. In 2009, the USA, Japan and the EU-27 accounted for 87.5 per cent of the global total. Within the EU, triadic protection is concentrated in Germany (12 per cent worldwide), France (5.1 per cent) and the UK (3.4 per cent), while in Spain it represented only 0.47 per cent worldwide.

The analysis of this drop in spending on innovation in the Spanish economy during the crisis has served as a stimulus to develop this study. A decline of innovation expenditure over several years would mean closures and increased fragility of the productive sector. This is why studying R&D and its relationship to the probability of business survival becomes important compared with other economic indicators.

The study has not referred to a patents indicator for two reasons: first, due to its small weight in the Spanish economy, where the number of applications is low (preference for trade secrets over patents) and concentrated in a few sectors (Hernández-Cerdán, 2002; Gámir and Durá,
and second, because, for technical reasons, not all innovations can be registered for patents.

Several surveys on entrepreneurship in Spain explain the strong relationship between R&D and entrepreneurial activity (García-Tabuenca et al., 2008, p. 145; 2012, p. 117 and 183). Specifically, a positive relationship between knowledge stock (total domestic expenditure on R&D accumulated from one period to the next, with an annual depreciation rate of 10 per cent, divided by GDP) and entrepreneurship has been found (Abellán-Madrid et al., 2011). However, on closer inspection, we find that, while R&D and entrepreneurship are clearly related, the relationship between R&D and the creation of companies is more erratic. Thus those regions with above average R&D/GDP expenditure may or may not register a higher creation of companies (birth rate), but they always have an above-average entrepreneurship level (number of companies/labour force).

This allows us to state our main study hypothesis: R&D is a key factor for entrepreneurial survival. This has been contested using data on the Spanish economy by Esteve-Pérez et al. (2004), although they work with R&D investment only as a dummy variable and do not carry out any regional analyses. This work aims for a more comprehensive insight, completing the evidence obtained in the previous work by carrying out a regional and sectoral analysis, distinguishing between technological and non-technological companies.

The analysis is therefore conditioned by four different technological environments that combine both regions and sectors where companies operate. This is because a technological company in a technological region faces competition that forces it to spend more on R&D. But, at the same time, being in such a region may have some advantages in terms of knowledge spillovers, making investment more profitable.

Thus our hypotheses are that a negative relationship between the level of R&D expenditure and exit probability can be expected, and that the level of that probability and the slope of the relationship will depend on the environment in which the firms operate.

The rest of the chapter is organized as follows. Section 2 presents a review of the literature, Section 3 is dedicated to data and methodology, Section 4 presents the results, and finally Section 5 contains conclusions and some suggestions regarding economic policy aimed at promoting R&D and therefore improving firm survival.
2. LITERATURE

R&D expenditure is a positive externality that needs government support to achieve a level in accordance with the social optimum. Therefore the market does not provide incentives for firms to allocate the right amount of resources to R&D (Arrow, 1962; Nelson, 1959), so public programmes arise with financial support for ensuring the right level of R&D and, at the same time, helping companies with costs, risks and uncertainties (Dasgupta and Maskin, 1987; Bloom, 2007) associated with innovation.

Achieving the social optimum level of R&D expenditure is therefore a generally accepted goal. Nevertheless, increasing R&D expenditure is not an end in itself but a way of obtaining positive effects for the economy as a whole. This takes us to the question of which are the expected results of the innovation effort and how they can be measured. The results traditionally expected are basically two: increase in productivity and sustainable economic growth.

Companies use R&D as an input in their productive process to obtain technological innovations. These innovations are intended to make the firm more competitive by improving its products or processes. Thus the firm can obtain a new or differentiated product or develop processes with lower costs. All those achievements can increase its productivity, improving its performance in the market.

A wide range of economic literature is devoted to the study of the impact of R&D on productivity and growth. Most of the studies use data at firm and industry level, but there are also works using data at the aggregate national level. Mansfield (1972), Nadiri (1993) and Link and Siegel (2003) use data from several industries in developed countries (the USA, Japan, France, among others) to show the increase in productivity due to R&D investment. This kind of studies follows the usual approach of estimating a production function (Griliches, 1979), where knowledge (proxied by the accumulation of private R&D investment) is one of the productive inputs.

The results are positive in general, but with variations depending on the industry, the period or the country. Thus, in the work by García-Manjón and Romero-Merino (2010) the authors provide a summary of studies with different results. For instance, the relationship can depend on the industry, being positive (the higher the R&D investments, the higher the production) in high-technology sectors (Chan et al., 1990; Coad and Rao, 2008) and negative in low-technology industries (Yu et al., 2008).

On the other hand, the studies by Lichtenberg (1992) or Birdsall and Rhee (1993), among others, use aggregate data from different OECD countries. The results are specific in every study, but R&D is always
significant for explaining economic growth. In this field, there are also some works that conduct growth accounting methods for measuring the impact of accumulated investment in R&D (knowledge stock) on the economic growth of a given country. Fraumeni and Okubo (2005), for instance, in a study for the USA, obtain a contribution of 0.38 percentage points to the GDP average annual growth rate for the period 1961–2000. Jones (2002) obtains a contribution for the same country of 1.4 percentage points in the period 1950–93. In Spain, Borondo (2008) finds a contribution of 1.0 percentage points to the growth of productivity (2.3 per cent) between 1968 and 2004.

Despite the positive effects of R&D, the effect of public programmes on R&D is not exempt from controversy, and numerous studies focus on determining if public support generates an increase in private expenditure on R&D or if, otherwise, it generates a crowding-out effect of this type of expenditure. Among others, David et al. (2000) and David and Hall (2000) have referred to confusing and frequently contradictory estimates of the response of company-financed R&D to changes in the level and nature of public R&D expenditure. Or, referring to the Spanish economy, Callejón and García-Quevedo (2002) and Aerts et al. (2007) have assessed the role of public policies in R&D and complementary effects on private investment, but also on the existence of substitution effects between tax incentives and direct support for R&D. The latter has been specifically mentioned to studies based on information from many OECD countries (Guellec and Pottelsberghe, 2001).

The patent races models introduce a new complexity factor (Loury, 1979; Lee and Wilde, 1980; Kwon, 2012, among others). Thus, in a scenario of patent competition, the situation is the opposite of the one described earlier: companies enter an expenditure race in R&D to achieve a patent. Finally, the winning firm obtains a return on the expenditure, while the expenditure made by the other companies can be seen as an inefficient overinvestment that exceeds the social optimum.

To sum up, R&D expenditure is a question of economic and social interest that usually implies government support for assuring the right level of expenditure and, therefore, a positive impact on entrepreneurship, productivity and economic growth. In this context, the study of the hypotheses of the present work contributes to finding out in detail how R&D expenditure generates economic growth: the improvement of firm survival.

There is a wide range of economic literature about firm survival. The works by Congregado et al. (2010 and 2011) have studied, from an aggregate viewpoint, the determinants of self-employment survival in the countries of the EU-15, and the role of innovation and knowledge in business
Innovation and entrepreneurship in the global economy

survival and success in these countries. Other works in this area have focused mainly on analysing, in the context of industrial organization, the processes of entry and exit of firms (Geroski, 1995; Segarra and Callejón, 2002). Nevertheless, plenty of works are focused on finding the factors that determine firm survival. Among these works should be mentioned the papers by Taffler (1982), Cuthbertson and Hudson (1996) and Lennox (1999), dedicated to studying financial ratios of companies as determining factors for exit, or the papers by Jovanovic (1982), Dunne et al. (1989) and Hopenhayn (1992), studying the influence of size and age of firms, or the one by Bhattacharjee et al. (2009) analysing the economic cycle as a determining factor of survival.

Among the works on firm survival in Spain are Fariñas and Moreno (2000), in which the authors find evidence about decreasing exit probability with size and age of firms. In the same line and for manufacturing firms in Portugal, Mata et al. (1995) show evidence of the importance of current size and post-entry growth on survival. However, the results of a survey conducted by Siegfried and Evans (1994) of over 70 empirical studies concerning entry and firm survival show that the influence of R&D and its intensity is confusing. Another survey on entry and survival literature can be found in Caves (1998).

Therefore survival depends on macroeconomic factors, such as the economic cycle, and microeconomic factors, internal to companies. Among these factors is R&D expenditure, which is, therefore, the hypothesis of the present work. As has been pointed out, R&D allows companies to obtain improvements in their products and processes that increase their productivity. These more productive firms have better tools for competing in the market and, ultimately, for surviving. Therefore R&D would become a key element for companies and governments, as firms committed to these activities are not only more productive, but also become stronger and have guarantees of long-run performance. This has consequences for the economy as a whole, which would benefit from a more productive entrepreneurship that generates economic growth, avoiding at the same time the social and economic costs associated with the death of firms.

The relationship between R&D expenditure and firm survival has been studied specifically in the work by Sharapov et al. (2011). The aim of their paper is to study the impact of R&D on survival, but conditioned to different technological environments. These environments are combinations of regions and sectors in which companies operate, generating four environments through the combination of technological regions and sectors with non-technological regions and sectors.

Thus the authors find that the technological intensity of the sector in which a company operates determines the amount of R&D expenditure
required for building and maintaining the absorptive capacity needed for competing in an effective way and, therefore, for survival.

On the other hand, the technological intensity of the region in which a company operates determines, because of the existence of knowledge spillovers, cost in terms of the R&D of generating innovations.

Thus a technological company established in a technological region faces sectoral competence that forces it to a higher level of R&D investment before reaching the point (T) at which the relationship between that investment and the probability of exit becomes negative. But, on the other hand, being in a technological region can mean that the company benefits from knowledge spillovers from other firms in the area, which means that R&D investment has higher returns once point T is reached.

Therefore an inverted-U-shaped relationship between R&D expenditure and the probability of exit is expected. The declining part of the U confirms that R&D investment helps in survival since it reduces the probability of exit. But that declining part will be reached earlier (in terms of R&D expenditure), depending on the sector (technological or not), and will have a different slope (R&D returns), depending on the region (technological or not). Nevertheless, the U-shaped relationship raises some questions, because it implies that the first investments in R&D are increasing the exit probability of firms, especially in those environments in which the inflexion point is reached very late.

The authors test this hypothesis using microdata on UK manufacturing companies’ R&D expenditure and survival between 1998 and 2005, finding significant evidence supporting the hypothesis.

In the case of Spain, the relationship between R&D expenditure and firm survival has been studied by Esteve-Pérez et al. (2004). In this work the authors work with a representative sample of manufacturing companies from the Encuesta sobre Estrategias Empresariales (ESEE – Business Strategies Survey) in the period 1990–99, using both non-parametric and semi-parametric survival methods. The results show that age of companies is significant in terms of firm survival, increasing the exit probability among younger and older firms in the sample. Another significant variable is size; thus the risk of exit is higher in small firms. The authors also find that survival probability is higher for exporting firms and for firms involved in R&D activities. They find that exporting firms have an exit probability 28 per cent lower than non-exporting companies. In the case of R&D, the results show that exit probability for innovative firms reduces by 57 per cent. These results, as the authors point out, are in line with the works by Audretsch (1995) and by Kimura and Fujii (2003).

Nevertheless, this work has some limitations. Thus both exporting and R&D activities enter the model as dummy variables, so the
model distinguishes only between doing R&D or not, not taking into account differences between levels of investment and between technological and non-technological sectors. On the other hand, the authors study the behaviour of firm survival at national level, without any regional disaggregation.

3. DATA AND METHODOLOGY

The work uses data from the survey Encuesta Sobre Estrategias Empresariales (ESEE) for the period 1991–2010. The survey is carried out annually by the SEPI Foundation, and is a panel survey of manufacturing firms located in Spain. The survey started in 1990 and, since that time, about 1800 firms have been surveyed each year (see Table 1.1). As the SEPI Foundation points out,

one feature that makes ESEE different from other statistics is its provision of information based on panel data, which has implied the systematic tracking of changes in the firms’ legal status. The ESEE covers a wide range of decisions that imply extraordinary changes in the firms’ life cycle (mergers, absorptions, splitting, adjustment plans for employees, segregation of assets, and so on) that must be controlled to ensure time comparisons. (https://www.fundacionsepi.es/esee/en/epresentacion.asp)

The study is therefore focused on manufacturing companies. The fact that innovation in services remains beyond the scope of many studies is a relatively common issue. Many works are focused on manufacturing firms, and in a study by Gómez Uranga et al. (2009), the authors refer to that point in these terms: ‘At the beginning, R&D activity was thought to be for industrial activities, with the purpose of generating new knowledge from it’; they also point out that ‘the identification of R&D expenditures has more complexities in services than in manufacturing industry’. Meanwhile, Gallego and Rubalcaba (2008), within the EU context, have referred to the particular features of innovation in services, emphasizing those features in comparison with profiles of innovation in goods.

Data from ESEE are used to estimate a Cox proportional hazard regression. This kind of regression is very common in works on firm survival. The goal is to assess the effect of covariates (a set of independent variables) on the hazard rate and on the probability of firm survival.

The hazard rate is the probability that failure (a firm exits the market) occurs in a moment \( t \) given that the firm has survived until that moment and conditional on a vector of covariates. The hazard rate can be expressed as follows (Kalbfleisch and Prentice, 1980), where \( F(t) \) is the probability...
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>2188</td>
<td>2059</td>
<td>1977</td>
<td>1869</td>
<td>1876</td>
<td>1703</td>
<td>1716</td>
<td>1920</td>
<td>1776</td>
<td>1754</td>
<td>1870</td>
<td>1724</td>
<td>1708</td>
<td>1800</td>
<td>1883</td>
<td>1764</td>
<td>1680</td>
<td>1577</td>
<td>1482</td>
<td>1676</td>
</tr>
<tr>
<td>Number of exits</td>
<td>62</td>
<td>54</td>
<td>72</td>
<td>53</td>
<td>51</td>
<td>28</td>
<td>35</td>
<td>18</td>
<td>45</td>
<td>38</td>
<td>20</td>
<td>18</td>
<td>51</td>
<td>4</td>
<td>17</td>
<td>35</td>
<td>30</td>
<td>57</td>
<td>127</td>
<td>67</td>
</tr>
</tbody>
</table>
that duration ($T$) is less than or equal to $t$. $S(t)$ is the survival function and gives the probability that a firm survives $t$ periods from 1991.

$$\lambda(t) = \lim_{\Delta t \to 0} \frac{\Pr(t + \Delta t > T > t|T > t)}{\Delta t} = \frac{dF(t)/\partial(t)}{S(t)}$$

To assess the effect of the explanatory variables on the risk of exit (controlling for the effect of other variables considered), we estimate the semi-parametric Cox proportional hazard model (Cox, 1972):

$$\lambda(t; X_{it}) = \lambda_0(t) \cdot \exp(X_{it}\beta)$$

In these kinds of model, any given firm faces a hazard rate that is a function of a baseline hazard rate $\lambda_0(t)$ that all firms face, transformed by a set of explanatory variables $X_{it}$ (covariates). Thus the hazard for one firm is proportional to the hazard for any other firm and the proportionality constant is independent of time.

The model is semi-parametric because the baseline hazard is an unspecified function, while the covariates enter the model linearly. The model is estimated maximizing a partial likelihood function with respect to the vector of coefficients.

The dependent variable in this kind of models is always a dummy variable that takes the value 1 if the firm exists. In the estimated model we have 4543 subjects with 671 failures.

The covariates are the following variables:

- Log (Average Labour Productivity) – a control variable defined as a ratio of total output in real terms to total number of employees.
- Foreign Capital Investment – a control variable that takes the value 1 if the share of foreign capital is more than 50 per cent and 0 otherwise.
- Log (Age) – consists of the data on the constitution date of every company and is a classic control variable in survival analysis.
- Log (Total Number of Employees) – a common control variable in works on firm survival. It is a proxy for size.
- Enterprise Group – a dummy variable that takes the value 1 if the firm belongs to an enterprise group and 0 otherwise.
- Concentration Rate – the market share of the four largest companies in the market.
- Product Standardization – a dummy variable that takes the value 1 if the product is standardized.
Log(RDT1–4) 1 – multiplicative variables. They use the logarithm of the ratio between expenditure in R&D and sales, multiplied by the environments (1 to 4). These variables enter the model with a lag of one period, reflecting the possible delay in the effect of R&D on firm survival. The ratio is expressed in given per 10,000. The environments are combinations of regions and sectors. Definitions are as follows:

- Environment1 – a dummy variable that takes the value 1 if the firm operates in a non-technological region and in a non-technological sector. As can be seen in Table 1.2, this environment represents 39.4 per cent of the sample of firms.
- Environment2 – a dummy variable that takes the value 1 if the firm operates in a technological region and in a technological sector. This environment represents 18.7 per cent of the sample of firms.
- Environment3 – a dummy variable that takes the value 1 if the firm operates in a non-technological region and in a technological sector. This environment represents 9.2 per cent of the sample of firms.
- Environment4 – a dummy variable that takes the value 1 if the firm operates in a technological region and in a non-technological sector. This environment represents 32.4 per cent of the sample of firms.

### Table 1.2 Descriptive statistics

<table>
<thead>
<tr>
<th>Dummy variables</th>
<th>Mean</th>
<th>Std dev.</th>
<th>% 1</th>
<th>% 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Labour Productivity</td>
<td>97175.47</td>
<td>182656.70</td>
<td>6.2</td>
<td>93.8</td>
</tr>
<tr>
<td>Foreign Capital Investment</td>
<td>25.03</td>
<td>21.45</td>
<td>30.7</td>
<td>69.3</td>
</tr>
<tr>
<td>Age</td>
<td>247.24</td>
<td>768.70</td>
<td>60.5</td>
<td>39.5</td>
</tr>
<tr>
<td>Total Number of Employees</td>
<td>RDT1</td>
<td>11.35</td>
<td>80.65</td>
<td>39.1</td>
</tr>
<tr>
<td>Enterprise Group</td>
<td>RDT2</td>
<td>35.66</td>
<td>174.24</td>
<td>18.6</td>
</tr>
<tr>
<td>Product Standardization</td>
<td>RDT3</td>
<td>12.55</td>
<td>122.94</td>
<td>9.2</td>
</tr>
<tr>
<td></td>
<td>RDT4</td>
<td>12.93</td>
<td>81.62</td>
<td>32.4</td>
</tr>
<tr>
<td>Average Age</td>
<td>25.03</td>
<td>17.10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Innovation and entrepreneurship in the global economy.

This environment represents 32.7 per cent of the sample of firms.

- Log (Average Age) – calculated from variable age and takes the average age of the firms of the sector in which every company operates. The variable is intended to be a proxy for industry turbulence, meaning that turbulent industries have a lower average age of companies.

Technological regions are considered to be Madrid, Cataluña, País Vasco and Navarra, according to the results presented in several works, for example Calderero and Kuitininen (2009), Reig (2007), López-García et al. (2009) or N-Economia (2012, pp. 29–30), and according to various regional technological measures and indicators, among which are investment in R&D, articles published in international journals, use of technology, telecommunications and internet access, e-commerce and so on by businesses, households and governments.

Technological sectors are considered to be, according to the classification of sectors included in the ESEE survey, the following: 9 (pharmaceutical and chemical industry), 14 (industrial machinery), 15 (computer system, electronic and optical products), 16 (electric material), 17 (motor vehicles) and 18 (other transport materials). Figure 1.1 shows the percentage of firms in technological sectors by regions. In general, technological regions

Figure 1.1  Percentage of firms in technological sectors by regions (NUTS-2)
have a greater percentage of firms in technological sectors, with the exception of Aragon, which has a greater percentage (43.9 per cent) in a non-technological region. This particularity might be due to the presence of technological spillovers from the neighbouring regions. In fact, the region of Aragon (NUTS-2) is successful in entrepreneurial activity, and together with Basque Country (36.4 per cent), La Rioja (10.3 per cent) and Navarre (34.3 per cent), forms the ‘Northeast’ (NUTS-1) region. This, along with ‘Madrid’ and ‘East’, are the three NUTS-1 regions, more advanced in terms of entrepreneurial dynamism and entrepreneurial creativity (Garcia-Tabuenca et al., 2011).

4. RESULTS

Results were obtained using a robust estimation for the errors and the Effron method for ties (when two or more firms exit at the same time). A proportionality test was implemented, and the assumption of proportional hazard can be accepted.

In Table 1.3 we present the results of the coefficients estimated for the covariates of the Cox model. Productivity is significant and negative, meaning that an increase in productivity, as expected, reduces exit probability (Carreira and Teixeira, 2011). The presence of foreign capital is significant but positive, and the same occurs with membership of an enterprise group. This is in line with Esteve-Pérez et al.’s (2004) results for Spain: ‘those firms with foreign capital participation bear a notorious higher risk of exit’.

Following with the control variables, variable Age is significant and positive, meaning that an increase in age increases exit probability; that is, older firms are more likely to exit. This is partly in line with the results of Esteve-Pérez et al. (2004), where the authors find that younger firms are more likely to exit, but also mature firms. Size (Total Number of Employees) is significant and negative, so the larger firms are less likely to exit. This is a classic result in the literature on firm survival (Esteve-Pérez et al., 2004; Carreira and Teixeira, 2011, among others). Concentration Rate is not significant, which is in line with the results of Sharapov et al. (2011). Product Standardization is strongly significant and positive, as can be expected: companies with more differentiated products (low standardization) are less likely to exit. This is pointed out in Holcombe (2009, p. 33): ‘The optimal competitive strategy is to seek ways of differentiating the firm’s output from that of other firms by creating a product that is more desirable to consumers. Indeed, this strategy is necessary for the survival of a competitive firm . . .’.
### Table 1.3 Cox proportional hazard model results

<table>
<thead>
<tr>
<th>Covariates</th>
<th>Coefficients</th>
<th>Hazard ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>log(Average Labour Productivity)</td>
<td>−0.2493</td>
<td>0.7792</td>
</tr>
<tr>
<td></td>
<td>(0.0605)***</td>
<td>(0.0471)***</td>
</tr>
<tr>
<td>Foreign Capital Investment</td>
<td>0.458</td>
<td>1.5809</td>
</tr>
<tr>
<td></td>
<td>(0.1533)***</td>
<td>(0.2423)***</td>
</tr>
<tr>
<td>log(Age)</td>
<td>0.5934</td>
<td>1.8101</td>
</tr>
<tr>
<td></td>
<td>(0.0450)***</td>
<td>(0.0814)***</td>
</tr>
<tr>
<td>log(Total Number of Employees)</td>
<td>−0.2701</td>
<td>0.7632</td>
</tr>
<tr>
<td></td>
<td>(0.0474)***</td>
<td>(0.0362)***</td>
</tr>
<tr>
<td>Enterprise Group</td>
<td>0.4263</td>
<td>1.5316</td>
</tr>
<tr>
<td></td>
<td>(0.1467)***</td>
<td>(0.2247)***</td>
</tr>
<tr>
<td>Concentration Rate</td>
<td>0.001</td>
<td>1.001</td>
</tr>
<tr>
<td></td>
<td>(0.0015)</td>
<td>(0.0015)</td>
</tr>
<tr>
<td>Product Standardization</td>
<td>0.3138</td>
<td>1.3687</td>
</tr>
<tr>
<td></td>
<td>(0.0824)***</td>
<td>(0.1129)***</td>
</tr>
<tr>
<td>log(RDT1)_1</td>
<td>−0.070</td>
<td>0.9318</td>
</tr>
<tr>
<td></td>
<td>(0.0430)</td>
<td>(0.0400)</td>
</tr>
<tr>
<td>log(RDT2)_1</td>
<td>−0.0754</td>
<td>0.9273</td>
</tr>
<tr>
<td></td>
<td>(0.0372)**</td>
<td>(0.0345)**</td>
</tr>
<tr>
<td>log(RDT3)_1</td>
<td>−0.1213</td>
<td>0.8857</td>
</tr>
<tr>
<td></td>
<td>(0.0620)*</td>
<td>(0.0549)*</td>
</tr>
<tr>
<td>log(RDT4)_1</td>
<td>−0.1305</td>
<td>0.8776</td>
</tr>
<tr>
<td></td>
<td>(0.0449)***</td>
<td>(0.0394)***</td>
</tr>
<tr>
<td>Environment2</td>
<td>0.5952</td>
<td>1.8135</td>
</tr>
<tr>
<td></td>
<td>(0.1539)***</td>
<td>(0.2791)***</td>
</tr>
<tr>
<td>Environment3</td>
<td>0.537</td>
<td>1.7109</td>
</tr>
<tr>
<td></td>
<td>(0.1871)***</td>
<td>(0.3201)***</td>
</tr>
<tr>
<td>Environment4</td>
<td>0.1627</td>
<td>1.1767</td>
</tr>
<tr>
<td></td>
<td>(0.1002)</td>
<td>(0.1179)</td>
</tr>
<tr>
<td>log(Average Age)</td>
<td>−2.7053</td>
<td>0.0668</td>
</tr>
<tr>
<td></td>
<td>(0.1155)***</td>
<td>(0.0077)***</td>
</tr>
</tbody>
</table>

**Observations**: 31,237

**Notes:**
Log-pseudolikelihood = −4384.4479.
Wald Chi² (15) = 754.36; p-value (0.000).
Standard errors in parentheses.
* Significant at 10%; ** significant at 5%; *** significant at 1%.

The last control variable is *Average Age* of the sector, which is used as a proxy for turbulence. The variable is highly significant and the coefficient presents a negative sign, so the lower the average age (more turbulence), the higher the exit probability. The variable would be a good proxy for
turbulence. Following Konings et al. (1996), ‘Firms operating in turbulent sectors experience a higher exit probability than firms operating in sectors with low turbulence . . .’.

The effect of R&D on firm survival can be observed through the variables RDT1 to RDT4, with a lag of one period. These variables are all significant (except for environment 1) and present a negative sign, showing that an increase in R&D expenditure generates a lower exit probability. This result confirms the main hypothesis of the chapter, showing how involvement in R&D activities lowers exit probability. Moreover, if we focus on the coefficients of the environments, they are all positive, so it is the effect of incorporating the R&D ratio that turns those signs into a negative impact on exit.

This can be also observed in the second column of Table 1.3, which shows the results of the estimation of the hazard ratios of the Cox models. These ratios are lower than 1 if the covariate contributes to reduce exit probability, and the opposite if the ratio is higher than 1. As can be seen, all the coefficients for the log(RDT) variables are under 1, showing that the effect of R&D is a reduction in exit probability between 8 and 11 per cent.

Figure 1.2 confirms again the main hypothesis of the present work, that is, the existence of a negative relationship between R&D ratio and exit probability in every environment, although this is not significant in environment 1. In addition, it shows the existence of two groups of environments with differentiated behaviours. Thus, in the upper part of the figure, with higher exit probabilities, there are two environments (2 and 3), both with technological sectors. In the lower part we have environments 1 and 4, with non-technological sectors and lower exit probabilities.

This result can be interpreted as a consequence of the more intensive competition and the uncertainties that are inherent in technological sectors, making them more turbulent and, therefore, having higher exit probabilities.

Another interesting result from Figure 1.2 is the big difference in returns between the first R&D investments and later ones. As can be seen, from a certain level of the R&D ratio, increasing it has almost no effect in terms of reducing exit probability. A kind of steady-state level is reached in every environment. Differences between environments are then found at lower levels of investment. At those levels, increasing the rate has different effects, depending on the environment.

In fact, increasing the R&D ratio from 1 per cent to 20 per cent results in the following reductions (Table 1.4) of the estimated exit probability in each environment.
As mentioned above, the ‘sector effect’ predominates, meaning that high-tech environments have higher exit probabilities, independent of region. The situation is the opposite for low-tech environments. It is therefore the risk associated with high-tech sectors that determines the level of exit probabilities.

Among the low-tech sectors (environments 1 and 4), it is in the low-tech regions (environment 1) where there are lower exit probabilities, making investment in R&D less relevant, as shown in the regression results. This can be also seen in Table 1.4, where this environment presents the lower effect when increasing the R&D ratio.

In the case of high-tech sectors (environments 2 and 3), there are two scenarios, before and after the intersection point. For our analysis, we can consider as relevant only the part before the intersection, given that
97.5 per cent of the observations for the ratio R&D/Sales in the sample are lower than 6 per cent (intersection point). Given the above, in the technological sector companies should be interested in being located in high-tech regions because of the lower exit probability. Behind this could be the existence in such regions of spillovers and synergies than could be useful for a tech company investing in R&D.

5. FINAL REMARKS

In the current context of economic crisis, it is necessary to find mechanisms that guarantee economic growth and long-term stability. Therefore knowing the factors that influence entrepreneurial activity and, mainly, the survival of those companies, is an ineluctable task.

The present work focuses on one of these factors, showing how innovative activity of companies not only makes them more productive and competitive, but represents a guarantee of survival. Assuring survival is a source of economic stability since social and economic costs associated with exit of firms are avoided.

As shown above, investment in R&D is always a way of reducing exit probability, with the exception of firms operating in non-technological sectors and in non-technological regions. In addition, this effect is stronger at the first level of investment, so it is critical to boost those companies that still have not initiated the investment process.

On the other hand, the need to rank equally with other developed countries, together with the current context of budget restrictions in the public sector, makes it advisable that this boost should be mainly based on private funds. The role of the public sector should therefore be focused on supervising and watching over companies that undertake these investments, building the right incentives and guaranteeing that scarce resources reach the companies that can obtain higher returns on them – those companies that are beginning their innovative processes.

In short, our empirical work has focused on the impact that technological effort (measured in R&D) of Spanish manufacturing firms has had on their survival. The period studied, between 1991 and 2010, has been used to collect in the aggregate analysis the effects of the economic cycle, less mortality of companies in the expansionary period (1995–2007) and more in recessions (1992–94 and 2008–10). It has proved the primary hypothesis, so that business survival is directly related to R&D effort. However, the sectors in which companies operate and the regional environment in which they are located (more or less technological intensity)
have significant influence on the magnitude of investment in R&D, which ensures survival. Thus R&D activities have no effect on survival of non-tech companies in non-tech regions, while they have a big impact for tech companies, mainly for those located in non-tech regions: they can improve their survival probabilities significantly through these activities, achieving the level of exit probability of the tech companies located in tech regions, that is, those with advantages associated with synergies and spillovers.

Our work has therefore two differentiating factors with respect to similar studies using Spanish economy data: R&D is not introduced as a dummy variable, and sectoral and regional segmentation is used. The first factor allows us to conclude that the main impact on survival is associated with the first stages of investment. The second one identifies the key role of R&D for tech companies operating in non-tech regions.

Both findings generate economic policy recommendations, as they provide evidence that suggests where to allocate R&D resources: firms that are at the beginning of their innovation process, rather than ‘innovation-mature’ firms, and tech firms in non-tech regions. This could act as a guide for project assessment, mainly in the actual context of budget constraints, where having rules for allocating scarce resources is highly valuable.

Finally, the work has some limitations that should be the object of further research. First of all, since the ESEE is a survey of manufacturing firms, the innovations of services companies are not taken into account. This is a relatively common limitation, as pointed by Gómez Uranga et al. (2009), because R&D was initially developed for industrial activities and because, in addition, identifying R&D expenses is a more complex task in services companies than in manufacturing firms.

Another limitation may lie in the variable used to proxy innovation, since the use of R&D implies focusing on technological innovations, omitting marketing or organizational innovations. It would be desirable, therefore, that further research on services companies take into account both technological and non-technological innovations.

NOTE

1. Following Toh and Choo (2002), a knowledge society or economy is one in which the generation and use of knowledge can be a source of economic growth, wealth and employment.
REFERENCES


2. Universities and public research institutes as collaboration partners for firms

Anders Broström and Maureen McKelvey

1. INTRODUCTION

The impact of university–industry collaboration on innovation has received much attention in the innovation literature. It has been argued that government-funded science has an important role to play not only for the economy *per se*, but also as a source of ideas, impulses and support of technological development for individual firms (Mansfield, 1998). However, the focus in the existing literature on universities has left part of the public science system out of systematic study: the role of public research institutes (PRIs). Our knowledge about the role of PRIs in collaboration networks is very limited. This chapter contributes by focusing on the role of PRIs in collaboration networks and by comparing the perceived effects of collaborating with universities and PRIs, respectively, from the firm’s perspective.

There are many different types of public research organization (PRO). While universities have a broader mandate including teaching and basic research, the primary objective for public financing of PRIs and laboratories is to interact with the private sector and to develop industrially relevant technology. Universities and PRIs thus constitute different institutional set-ups. Previous research has demonstrated that the institutional set-up of public research affects the nature of interaction with the private sector. Due to institutional differences, we can expect differences between PRIs and universities in terms of mission, culture and research scope (Bozeman, 2000). The literature on external relations in innovation offers convincing arguments that patterns of cooperation are different for different types of aims and scope of collaboration, but the link between different rationales for collaboration and the choice of collaboration partner has not been adequately studied.

In spite of substantial governmental spending on PRIs in many countries,
the sector has been largely ignored in previous studies of PRO–industry linkages. In the scarce literature that exists (Crow and Bozeman, 1998; Lundvall, 1992), the PRI sector is described as a complement to universities, dedicated to applied R&D and to interaction with industry, whereas universities are typically associated with ‘curiosity-driven’ research.

However, systematic empirical investigations of the proposition of potential differences are few and far between. Even when PRIs are included in studies on collaborative linkages between public and private R&D, the distinction between universities and PRIs is commonly ignored. For example, PRIs are included as a distinguishable group in the YALE and CIS surveys, but studies abstain from analysing collaboration with this particular group (cf. Klevorick et al., 1995). Later literature similarly aggregates universities with PRIs into a general category of PROs, including many studies reporting from, for example, the PACE, KNOW and CIS surveys (cf. Faulkner and Senker, 1993; Beise and Stahl, 1999; Cohen et al., 2002; Arundel and Geuna, 2004; Fontana et al., 2006; Cassiman and Veugelers, 2002; Tether and Tajer, 2008). Hence existing literature has not yet distinguished between the benefits for firms of interacting with universities, as compared with PRIs, and this is therefore a contribution of this chapter.

While knowledge transfer from PROs to the wider economy has been found to take place through a number of different channels, firms report that the most important type of linkage to generate firm-level benefits from interactions with PROs are interactions that are direct and formalized – a finding confirmed both for universities (Kaufmann and Tödtling, 2001) and PRIs (Adams et al., 2003). This chapter therefore also focuses on direct, formalized interactions with universities and PRIs, and especially how and why firm managers perceive them to generate firm-level benefits.

This chapter analyses the role of institutional differences by relating them to different objectives of firms engaged in formal interaction with the PROs, including both PRIs and universities. In particular, we build on the findings of Klevorick et al. (1995), Cohen et al. (2002) and Fontana et al. (2006), who report that academic research contributes to two distinct types of objective: generation of new ideas and impulses; or development work that helps the firm complete innovation projects. The difference between these two objectives can also be stated as the difference between ‘learning what you need to learn’ and acquiring assistance in innovation projects already defined by the firm. The first question we pose is whether the different institutional set-up of PRIs and universities makes them differently suited to provide either one of these benefits to industrial firms.

The second question that we investigate is whether PRIs and universities
have different ability to support firms in more ‘basic’ R&D and in applied R&D, respectively. Following Aghion et al. (2008), we use the terms basic and applied R&D to relate to the distance between the current innovation phase and a marketable product, rather than to the classical definition, by which basicness is related to degree of appropriability (Nelson, 1959). In works following this classical approach, the analysis of the basic nature of research is conceptualized as related to the knowledge involved per se. In contrast, by adopting the reification of Aghion et al., we can use the distinction between basic and applied research to discuss and empirically investigate interaction outcomes from the market-oriented perspective of the firm.

This chapter is based on data collected through a survey of Swedish firms in the engineering and manufacturing sectors to examine collaborative linkages, and the data are assessed in a sample selection probit framework. There was a 68 per cent response rate. In total, responses from 425 workplaces are analysed.

The chapter is organized as follows: Section 2 discusses how the existing literature helps generate the two hypotheses explaining why differences in organizational set-ups may give universities and PRIs different roles as collaboration partners for industry. Section 3 presents data collected to test the two hypotheses derived in the previous sections, and Section 4 presents the modelling framework within which the data are tested, and the results of these tests. Section 5 concludes the chapter.

2. THE COMPLEMENTARY ROLE OF INDUSTRIAL PUBLIC RESEARCH INSTITUTES

This chapter adds to a growing stream of research that seeks to improve our understanding of the role of public sector R&D in modern economies by turning attention to the role of a number of interrelated institutional factors such as organization, research management, incentives and (local) culture (Bonaccorsi, 2007; Carayol and Matt, 2004). While many recent studies have investigated how institutional differences shape differences in academic collaboration patterns (Heinze and Kuhlmann, 2008; Boardman and Corley, 2008), there is a parallel interest in how technology transfer from public organisations is mediated by institutional factors. Bozeman and Crow (1991) sample 134 government labs and 139 university labs in the USA. They find that labs with ‘commercial’ efficiency criteria are more likely to report involvement in technology transfer to industry. Baldini et al. (2006) conclude that differences in patenting activity by Italian universities are to a large degree explained by differences in internal regula-
tions about immaterial property. Lach and Schankerman (2008) show that those universities in the USA that provide stronger royalty incentives to faculty scientists generate greater licence income, controlling for university characteristics. When comparing two types of organizational forms for universities (public and private), the authors find that the impact of incentives is larger in private universities. Ponomariov (2007) estimates the effect of select university characteristics on the propensity of individual scientists to interact with firms. He finds that academics active at institutions with many industrial establishments on campus and, interestingly, with relatively low academic prestige are most likely to report interaction with firms.

Only a handful of previous studies have empirically contrasted the knowledge base of public labs and institutes with that of universities, and almost all the available studies describe the situation in the USA. Crow and Bozeman (1998) discuss how US government labs are characterized by more ‘applied’ research, whereas universities are said to be oriented towards ‘basic’ research. Somewhat contrasting evidence is presented by Jaffe and Trajtenberg (1996) and Jaffe and Lerner (2001), who find that, while the labs lagged behind universities in terms of both patenting volume and patent quality in the 1970s and early 1980s, that gap was closed during the 1990s, making the public labs more similar to universities. A corresponding European trend towards convergence between the functions of different actors within the broader public research organizations has been reported by Senker (2006).

The first question addresses whether universities and PRIs are differently suitable to provide firms in their networks with impulses and novel ideas for innovation, and with concrete assistance in R&D projects, respectively. In this chapter, we focus on institutional differences driven by differences in terms of organizational mission, in relation to benefits for the firms. We view a university as an institution governed by academic rules, norms and incentives (Dasgupta and David, 1994). Researchers are exclusively rewarded on the basis of peer review and on the impact of academic publications. Importantly, individual scientists retain the right to decide what projects to take on. In contrast, we view a PRI as a hybrid form organization, where one key mission is to perform R&D relevant for innovation and to interact with private businesses. This mission is manifested as managerial control and coordination mechanisms (Bozeman, 2000; Gulbrandsen, 2011). Control mechanisms and a reward system only partly based on academic publication impact also give PRI researchers greater incentives to avoid the ‘publish or patent’ problem of compromised academic freedom characterizing many university–industry relationships (Lee, 1996).
Innovation and entrepreneurship in the global economy

Based on such differences, we expect PRIs to be better positioned than universities to interact with firms on the basis of agreed contracts. These contracts should give the firm the ability to control the interaction, so that the focus remains on a problem or task specified by the firm. In the terminology of principal–agent theory, we expect firms to face a greater agency problem when dealing with university researchers as compared to PRI researchers. Furthermore, a relationship where the principal’s influence over the agent is strong may not be flexible enough to stimulate the emergence of new ideas and interactive learning (Liebeskind et al., 1996; Blanc and Sierra, 1999). For both these reasons, interaction with a PRI should be less likely to generate new ideas, while, in contrast, it is reasonable to expect that interactions with a university could contribute to the generation of new ideas and impulses to innovation, rather than support innovation projects already defined by the firm. We formulate this expectation as the following hypothesis:

H1: Interaction with universities is more likely to be focused on the generation of ideas and impulses to innovation as compared with interaction with PRIs.

Our second question tackles the differences between two types of projects that firms may undertake in interaction with PROs. The first type is long-term development of technology and exploratory R&D, which are not expected to result in new or significantly improved products or processes within the timeframe of a year. The second type are projects related to well-specified product and process development in mature development stages, and this is typically thought of as very applied R&D. The two types can be thought of as ‘early-stage’ and ‘late-stage’ R&D in a process of continuous refinement where the end result is a marketable product (Aghion et al., 2008). We expect researchers in universities to have lower incentives than their colleagues in PRIs to engage in interaction in projects with firms where the objective is short-term development. This expectation builds on a stylized view of such short-term projects as typically not generating academic research results, whereas universities are governed by academic rules, norms and incentives. Even though previous research has shown that university researchers can use contacts with applied research problems in firms to inspire further research and help them fund their departments (Lee, 2000), the total incentive of the typical university researcher should be lower than that of the typical PRI-employed researcher. Furthermore, previous research suggests that academic quality is positively associated with firms’ interest in engaging in joint-venture research and other forms of interaction associated with exploratory rather than with strictly
applied purposes (Schartinger et al., 2002). In consequence, we expect the following:

**H2**: Interaction with PRIs is more likely to contribute to the execution of short-term innovation projects than contacts with universities.

To summarize, we predict that firms will be more likely to use universities as ‘listening posts’ for ideas and impulses, and to use PRIs as suppliers of applied services to complete development projects defined by the firm. These hypotheses, if confirmed, would confirm a view of the ‘division of labour’ between universities and PRIs in a national innovation system (Nelson, 1993; Arnold et al., 1998).

### 3. DATA, METHODOLOGY AND DESCRIPTIVE RESULTS

Our hypotheses are tested on data about the interaction patterns of Swedish firms in the manufacturing and engineering sectors. The Nordic countries are interesting test-beds for studying university–industry collaboration, since the activity level in these countries is higher than in other EU countries, as revealed by the European Community Innovation Surveys (CIS). There are thus reasons to expect Nordic firms to have relatively long experience with collaboration, and to have developed strategies for interaction with universities and PRIs. By restricting the study to engineering and manufacturing sectors, we focus on the sector most clearly targeted by Nordic PRIs, and the sector where the interest in interaction on applied research is at its highest. We therefore predict that the potential for successful division of labour will be at its greatest in this sector.

#### 3.1 Data and Methodology

The main source of our data is a survey conducted during 2007. From the total population, 425 establishments in Swedish engineering and manufacturing sectors were randomly selected, stratified by establishment size. All establishments were contacted by phone and asked to identify the most suitable respondent for our survey. The initial contact at the establishment was asked to identify the R&D manager in charge of external relations, general R&D manager, technology manager, production manager or site manager/CEO, in descending order of priority. The identified respondents were then contacted by e-mail and given the chance to respond to the survey electronically or to indicate that they did not want to participate.
After one week, a second e-mail was sent, reminding them about the survey. In parallel, respondents who had not responded to the survey were contacted by phone and asked to complete the survey by interview. After three weeks of intensive contact efforts, a final e-mail was sent out. In total, 68 per cent of the respondents completed the survey. A further 6 per cent gave partial, but incomplete, answers to the survey.

Respondents were asked to answer questions regarding the formal interaction of their establishment with five categories of PRO, namely: universities in own county; domestic universities outside own county; foreign universities; domestic PRIs and foreign PRIs. For each category, the respondent was asked to state whether his/her workplace had had R&D collaboration with a partner in this category in the period 2004–06. For each category, respondents were then asked to assess three possible benefits from collaboration:

A1: Interaction has helped the firm suggest and formulate new innovation projects
A2: Interaction has contributed to the execution of long-term innovation projects
A3: Interaction has contributed to the execution of short-term innovation projects.

A respondent who reported experience from interaction with PROs in each of the five categories thus made 15 assessments in total. Assessments were made on a three-level Likert scale, offering the alternatives ‘not at all’, ‘to some extent’ and ‘to a significant extent’. From these assessments, we construct two measures corresponding to our two hypotheses:

\[
focus \text{ on learning} = 1 \text{ if } A1 > \max(A2, A3)
\]
\[
focus \text{ on short-term effects} = 1 \text{ if } A3 > A2
\]

The results reported reflect ex post assessment of recent contacts with PROs. Our discussion and the survey questions used here focus on the managers’ experience of what has actually been achieved through collaboration in recent years. To investigate similarities and differences between firm strategy (ex ante) and managers’ perceptions about the benefits of collaboration (ex post), we conducted complementary interviews with a subset of 18 firms. These firms had answered the survey, and the interviews allowed us to explore the connection between firm strategy and the survey results in terms of managers’ perceptions.

Through the interviews, we found no indications that ex ante strategic
objectives and *ex post* outcomes differed substantially for larger firms with more advanced R&D capabilities and for firms with continuous contacts with PROs. However, we could identify a number of cases where those firms that were inexperienced in working with academics reported differences in expectations and experiences in terms of the three outcomes A1–A3 listed above. In particular, the interviews revealed examples where firms with less advanced R&D capabilities reported that they had engaged with PROs with the purpose of gaining assistance in existing R&D projects and failed to achieve these objectives. Where such experiences generated ideas and impulses to further R&D through beneficial serendipity, a linkage will be considered as having had a *de facto* focus on learning.

For each firm that answered the survey, supplementary data on sector codes, firm and workplace size, as well as location, were supplied by Statistics Sweden. Data on the number of patent applications filed at the Swedish patent bureau and the European Patent Office (EPO) by the firm to which the workplace belongs were added from the PATSTAT database of the EPO.

For the PROs most frequently identified as collaborators by answering firms, we also gathered additional data about funding, employees and publications. See the Appendix to this chapter.

Our data on the managers’ perceptions of benefits, or what we call assessments, are used so that each assessment is modelled on the framework of an ordered logit or probit model, with appropriate controls for selection bias. By adopting the two transformed variables *focus on learning* and *focus on short-term effects*, we gain two important advantages. First, as is usual when Likert scales are applied, there is a tendency to respond with the middle alternative in the data, expressed here as ‘to some extent’. The transformed variables allow us to study the probability that a respondent not only agrees with all three statements without further reflection, but is also actively making a judgement differentiating between the three different questions posed. Second, because the group of firms interacting with PROs is clearly a selective group as compared to all firms, we should seek to compensate for selection bias. However, the decision to interact with a PRO and the assessment of the utility of that interaction can, theoretically, be thought of as outcomes of the same basic models. Therefore we will not be able to control for the selection mechanism through which the data have been censored (i.e. that assessments are observed only for interacting firms) when modelling the assessments directly in a probit sample selection framework.3
3.2 Descriptive Results

In the stratified sample, the responses indicate extensive interaction with PROs. Of the respondents, 32 per cent report collaboration with both PRIs and universities. Of the total, 37 per cent report collaborative relations with PRIs, and 64 per cent with universities. A further 11 per cent of those who report interacting with universities report that they do so exclusively through student projects, such as a Master’s thesis. Given the purpose of this chapter, these latter observations are considered non-collaborators as the student projects are not part of the direct, formal interactions studied here.

Table 2.1 provides an overview and descriptive statistics of the variables. As demonstrated in Table 2.1, the observed establishments are distributed equally among the five size classes and among the four broad sectoral classifications – the exception being the machine manufacturing sector, to which two out of five observations belong. One out of two observed linkages are reported by firms for which PRO contacts are assessed as being of strategic importance as inputs for their innovation processes.

Table 2.1 also reveals that a majority of the observed firm–PRO linkages are not assessed as having a focus on learning or a focus on short-term effects. That is, the average link is deemed to contribute to project completion as least as much as to generation of new ideas. This suggests that the occurrence of useful impulses to further R&D in practice is often linked to the achievement of objectives related to ongoing R&D projects of the firm (Broström, 2014). The observation that long-term R&D objectives are a key driver of firm–PRO relationships also fits well with results from recent research on Sweden that suggests that firms engage universities in projects that consolidate the firm’s technological project (Ljungberg and McKelvey 2012; Ljungberg et al., 2013).

Table 2.2 shows that the same factors drive both types of collaboration, as evident from the estimation of a probit model, namely firm size and conducting R&D. The results indicate that our data replicate previous findings on the impact of firm size and R&D intensity (here proxied by dummies for patent application and for the sector registered as R&D performing) reported to influence the propensity to interact with universities in previous studies (Laursen and Salter, 2004).

Comparing predicted and observed values, we find that 70 per cent of all predictions of university collaboration are correct, in the sense that a non-collaborator is assigned a prediction of less than 50 per cent probability of interacting and collaborators are assigned a prediction of over 50 per cent. The corresponding share of correctly predicted observations in the institute model is also 70 per cent. There are thus reasons to expect
Table 2.1  Summary of utilized variables; N = 1455

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Mean</th>
<th>Std dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Link-specific variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>focus on learning</td>
<td>The link is assessed as contributing more to impulses for innovation than to implementation of existing R&amp;D projects (= 1)</td>
<td>0.12</td>
<td>0.36</td>
</tr>
<tr>
<td>focus on short-term effects</td>
<td>The link is assessed as contributing more to the execution of short-term R&amp;D projects than to R&amp;D projects with a long-term perspective (= 1)</td>
<td>0.16</td>
<td>0.37</td>
</tr>
<tr>
<td>strategic importance</td>
<td>At least one link to PROs is assessed as contributing to the firm’s innovation activities ‘to a significant extent’</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>institute</td>
<td>Link to PRI (= 1) rather than university (= 0)</td>
<td>0.40</td>
<td>0.49</td>
</tr>
<tr>
<td>county</td>
<td>Link within county (= 1) or outside county (= 0)</td>
<td>0.20</td>
<td>0.40</td>
</tr>
<tr>
<td>foreign</td>
<td>Link to foreign partner (= 1) or domestic partner (= 0)</td>
<td>0.40</td>
<td>0.49</td>
</tr>
<tr>
<td><strong>Establishment-specific variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>urban</td>
<td>Situated in a region with major urban centres and significant academic resources (= 1)</td>
<td>0.10</td>
<td>0.31</td>
</tr>
<tr>
<td>local access</td>
<td>A logged measure of the number of academic researchers in technical fields who are employed in the county of the workplace</td>
<td>4.8</td>
<td>2.2</td>
</tr>
<tr>
<td>metals</td>
<td>Classified as a producer of basic metals or simple metal products (= 1)</td>
<td>0.20</td>
<td>0.40</td>
</tr>
<tr>
<td>machinery</td>
<td>Classified as a manufacturer of machinery (= 1)</td>
<td>0.42</td>
<td>0.49</td>
</tr>
<tr>
<td>transport</td>
<td>Classified as a manufacturer of transport equipment (= 1)</td>
<td>0.17</td>
<td>0.38</td>
</tr>
<tr>
<td>r&amp;d</td>
<td>Classified as a performer of technical R&amp;D (= 1)</td>
<td>0.21</td>
<td>0.41</td>
</tr>
<tr>
<td>size1</td>
<td>20–49 employees (= 1)</td>
<td>0.25</td>
<td>0.43</td>
</tr>
<tr>
<td>size2</td>
<td>50–99 employees (= 1)</td>
<td>0.17</td>
<td>0.37</td>
</tr>
<tr>
<td>size3</td>
<td>100–199 employees (= 1)</td>
<td>0.19</td>
<td>0.39</td>
</tr>
<tr>
<td>size4</td>
<td>200–499 employees (= 1)</td>
<td>0.25</td>
<td>0.44</td>
</tr>
<tr>
<td>size5</td>
<td>500+ employees (= 1)</td>
<td>0.14</td>
<td>0.33</td>
</tr>
<tr>
<td><strong>Firm-specific variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>number of workplaces</td>
<td>Number of workplaces in firm</td>
<td>1.1</td>
<td>4.2</td>
</tr>
<tr>
<td>age</td>
<td>Firm age</td>
<td>13.2</td>
<td>7.0</td>
</tr>
</tbody>
</table>
Innovation and entrepreneurship in the global economy

Table 2.2 Coefficient estimates, probit models

<table>
<thead>
<tr>
<th></th>
<th>Interacts with university</th>
<th>Interacts with public research institute</th>
</tr>
</thead>
<tbody>
<tr>
<td>patent applicant</td>
<td>0.2350</td>
<td>0.3917**</td>
</tr>
<tr>
<td></td>
<td>(0.127)</td>
<td>(0.129)</td>
</tr>
<tr>
<td>machinery</td>
<td>−0.3071*</td>
<td>−0.2426**</td>
</tr>
<tr>
<td></td>
<td>(0.147)</td>
<td>(0.149)</td>
</tr>
<tr>
<td>transport</td>
<td>−0.4762**</td>
<td>−0.6520**</td>
</tr>
<tr>
<td></td>
<td>(0.183)</td>
<td>(0.196)</td>
</tr>
<tr>
<td>r&amp;d</td>
<td>0.9007**</td>
<td>0.4885**</td>
</tr>
<tr>
<td></td>
<td>(0.202)</td>
<td>(0.180)</td>
</tr>
<tr>
<td>size2</td>
<td>0.3250**</td>
<td>0.2918**</td>
</tr>
<tr>
<td></td>
<td>(0.190)</td>
<td>(0.202)</td>
</tr>
<tr>
<td>size3</td>
<td>0.7801**</td>
<td>0.4389*</td>
</tr>
<tr>
<td></td>
<td>(0.184)</td>
<td>(0.194)</td>
</tr>
<tr>
<td>size4</td>
<td>1.038**</td>
<td>0.7387**</td>
</tr>
<tr>
<td></td>
<td>(0.186)</td>
<td>(0.192)</td>
</tr>
<tr>
<td>size5</td>
<td>0.8409**</td>
<td>1.281**</td>
</tr>
<tr>
<td></td>
<td>(0.227)</td>
<td>(0.228)</td>
</tr>
<tr>
<td>urban</td>
<td>0.3754</td>
<td>0.3777**</td>
</tr>
<tr>
<td></td>
<td>(0.216)</td>
<td>(0.183)</td>
</tr>
<tr>
<td>number of workplaces</td>
<td>0.0015</td>
<td>0.0022</td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
<td>(0.014)</td>
</tr>
<tr>
<td>intercept</td>
<td>−0.3391*</td>
<td>−1.070**</td>
</tr>
<tr>
<td></td>
<td>(0.162)</td>
<td>0.176</td>
</tr>
<tr>
<td>LR chi²(10)</td>
<td>107.96</td>
<td>115.52</td>
</tr>
<tr>
<td>Pseudo R²</td>
<td>0.1423</td>
<td>0.1505</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses. * 5% significance; ** 1% significance.

that interaction with both types of organization is also driven by additional factors, which are unobserved in the present model. Differences in terms of firms’ orientation and organization of R&D activities and differences in R&D intensity probably constitute important, unobserved factors for the decision to interact (Laursen and Salter, 2004).

In a first test of our hypotheses H1 and H2, we study the differences between the reported linkages to universities and to institutes, respectively.

From the results in Table 2.3, we can conclude that, among the observed linkages, firms are more likely to focus on learning in interactions with universities, seemingly supporting H1. However, when focusing on short-term effects, firms are equally likely to work with both kinds of public
research partners. There is thus no support for H2 from a simple group comparison.

These results give a first analysis, but the analysis in the next section proposes a more thorough approach, to allow for generalization of these results. First, we need to control for factors that, independent of the organizational form of the public science partner, may drive these assessments. Second, we need to control for the selection bias problem invoked by the fact that firm managers can only report assessment on linkages of which they have experience. In particular, since most firms collaborating with PRIs also collaborate with universities, but almost half of the firms collaborating with universities do not collaborate with institutes, there may be systematic differences between the two groups that, if not properly controlled for, would bias the results.

4. MODEL AND RESULTS

Out of 1455 observations of managers’ experiences (answers regarding five categories of PROs provided by managers from 291 establishments), only 453 assessments of linkage effects are actually observed – managers can assess collaboration only of the types of which they have experience. Almost two-thirds of all observations on the dependent variables thus have a missing value. Theoretically, the dependent variable is observed only if a particular condition \((\text{sel}_i = 1)\) is met. We therefore utilize a sample selection probit model, as is common practice in the literature.\(^4\)

The selection variable is modelled as

\[
\text{sel}_i = 1 \text{ if } z_{ij} \cdot \beta_j + \nu_i > 0 \text{ else } \text{sel}_i = 0
\]

Table 2.3  Differences in reported focus between assessments of university and institute linkages

<table>
<thead>
<tr>
<th>Variable</th>
<th>All linkages</th>
<th>Linkages to universities</th>
<th>Linkages to institutes</th>
<th>Test for difference: (t)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link-specific variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>focus on learning</td>
<td>0.12</td>
<td>0.14</td>
<td>0.08</td>
<td>1.76 *</td>
</tr>
<tr>
<td></td>
<td>(0.33)</td>
<td>(0.35)</td>
<td>(0.27)</td>
<td></td>
</tr>
<tr>
<td>focus on short-term effects</td>
<td>0.17</td>
<td>0.16</td>
<td>0.17</td>
<td>−0.32</td>
</tr>
<tr>
<td></td>
<td>(0.37)</td>
<td>(0.37)</td>
<td>(0.38)</td>
<td></td>
</tr>
</tbody>
</table>

Note: * 5% significance.
The observed response \( i \) is modelled as

\[
\text{focus}_i = 1 \text{ if } x_{i,j} \cdot \delta_j + \varepsilon_i > 0 \text{ else } \text{focus}_i = 0
\]

The residuals \( u_i \) and \( e_i \) are assumed to have a bivariate normal distribution, and the two equations are thus estimated by maximum likelihood in a two-step procedure. \( z_{ij} \) and \( x_{ij} \) should differ in at least some of their components, that is, not be made up of the same variables.

In modelling the selection equation, we use the model of Table 2.2, which uses firm and workplace-specific variables to predict a firm’s probability of interacting with PROs, as our point of departure. We furthermore include linkage-specific dummy variables on geography, as regional linkages are reported more frequently and linkages to foreign PROs less frequently than domestic (non-regional) PROs (county, foreign), and a dummy indicating whether the linkage is to a PRI rather than a university (pri).

In the second step, we model the likelihood of linkage being focused (focus on learning and focus on short-term effects, respectively) as a function of seven dummy variables. The variable in focus is pri. We control for whether the link is foreign or domestic, as considerable geographical distance could be thought to hinder learning and short-term effects (Broström, 2010). We furthermore add a workplace-specific variable indicating whether the respondent has assessed any link to PROs as contributing to any of our three effects ‘to a significant extent’; that is, whether PRO linkages in general are identified as strategically important. The rationale for including this variable, called strategic importance, is that it proxies whether interaction with PROs is an important activity in the innovation processes of the establishments, or a more marginal activity. Lastly, we also include establishment-specific controls for the technology level of the firm, proxied by patent applicant, and for the sector of the workplace.

When applying the controls discussed in the previous section, we find support for H1, but not for H2. This relationship is shown in Table 2.4. Interestingly, we also find that firms that report PRO contacts to be important (as measured by the variable strategic importance) are also more likely both to report a focus on learning and a focus on short-term effects in their linkages to PROs. Our interpretation of this finding is that firms for which interaction with PROs is an important and prioritized activity learn to organize their contacts with different PROs in a way that allows them to focus their activities to suit themselves.

It is also noteworthy that two variables proxying for relatively high competence in R&D (r&d and patent applicant) are negative and largely insignificant. It thus seems that, if advanced firms behave differently from
Table 2.4 Estimation results, probit model with sample selection

<table>
<thead>
<tr>
<th></th>
<th>focus on learning</th>
<th>focus on short-term effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome equation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pri</td>
<td>−0.416 **</td>
<td>0.096</td>
</tr>
<tr>
<td></td>
<td>(0.150)</td>
<td>(0.154)</td>
</tr>
<tr>
<td>strategic importance</td>
<td>0.438 **</td>
<td>0.274 *</td>
</tr>
<tr>
<td></td>
<td>(0.132)</td>
<td>(0.135)</td>
</tr>
<tr>
<td>foreign</td>
<td>−0.531 **</td>
<td>−0.372 *</td>
</tr>
<tr>
<td></td>
<td>(0.176)</td>
<td>(0.185)</td>
</tr>
<tr>
<td>patent applicant</td>
<td>−0.160</td>
<td>−0.153</td>
</tr>
<tr>
<td></td>
<td>(0.149)</td>
<td>(0.153)</td>
</tr>
<tr>
<td>r&amp;d</td>
<td>−0.246</td>
<td>−0.552 *</td>
</tr>
<tr>
<td></td>
<td>(0.207)</td>
<td>(0.228)</td>
</tr>
<tr>
<td>machinery</td>
<td>−0.294</td>
<td>−0.186</td>
</tr>
<tr>
<td></td>
<td>(0.182)</td>
<td>(0.184)</td>
</tr>
<tr>
<td>transport</td>
<td>−0.318</td>
<td>−0.392</td>
</tr>
<tr>
<td></td>
<td>(0.234)</td>
<td>(0.244)</td>
</tr>
<tr>
<td>constant</td>
<td>−1.90</td>
<td>−1.74 **</td>
</tr>
<tr>
<td></td>
<td>(0.353)</td>
<td>(0.366)</td>
</tr>
<tr>
<td>Wald χ²(12)</td>
<td>36.53 **</td>
<td>17.33 *</td>
</tr>
</tbody>
</table>

| **Selection equation**         |                  |                            |
| urban                          | 0.523 **         | 0.497 **                   |
|                                | (0.114)          | (0.115)                    |
| foreign                        | −0.588 **        | −0.580 **                  |
|                                | (0.086)          | (0.086)                    |
| county                         | 0.262 (**)       | 0.315 **                   |
|                                | 0.103            | (0.102)                    |
| pri                            | −0.229 **        | −0.206 *                   |
|                                | (0.085)          | (0.086)                    |
| size dummies                   | Yes              | Yes                        |
| sector dummies                 | Yes              | Yes                        |
| constant                       | −0.873 **        | −0.886 **                  |
|                                | (0.125)          | (0.125)                    |
| LR test of independent equations: χ²(1) | 6.17 *          | 5.52 *                     |

Notes:
Standard errors in parentheses. * 5% significance; ** 1% significance.
* As stratified sampling procedures may induce heteroscedasticity problems, we test for such problems using standard F-tests on variance equivalence. The only problem indicated by such a test refers to the variable r&d. These problems do not seem to significantly affect the results.
non-advanced firms, it is in the form of a more distinct emphasis on the pursuit of long-term, well-defined R&D objectives in their interaction with PROs. A possible interpretation is that these firms are more likely than non-advanced firms to interact with PROs in work related to the development of generic technology or technology standards.

5. CONCLUSIONS

In this chapter, we examined how firms assess the value of their interactions for R&D within two different types of actor that can both be considered public research organizations (PROs), namely public research institutes (PRIs) and universities. In spite of substantial governmental spending on PRIs in many countries, the sector has been largely ignored in previous studies of PRO–industry linkages. In the scarce literature that exists (Crow and Bozeman, 1998; Lundvall, 1992), the PRI sector is described as a complement to universities, dedicated to applied R&D and to interaction with industry, whereas universities are typically associated with ‘curiosity-driven’ research. Following these suggestions about their differing roles in technology development, we proposed and tested two hypotheses predicting that interactions with universities would be more likely to have a focus on learning while interactions with PRIs would be more likely to have a focus on short-term effects.

In order to test whether these two systems fulfil similar or quite different roles as R&D partners to industry, we asked R&D managers at 425 establishments in Swedish engineering and manufacturing sectors to assess the utility of all existing partnerships with both kinds of PROs, with a 68 per cent response rate to the survey. We used the managers’ assessments of the value of partnerships in order to characterize each observed firm–PRO linkage in terms of whether it was perceived to have a focus on learning and a focus on short-term effects, respectively.

The results provide evidence in support of our first hypothesis, namely that a partnership with universities is more likely to be focused on generation of impulses to innovation, as compared with partnership with PRI. To the extent that firms use contacts with PROs to generate ideas and as ‘listening posts’, such arrangements are set up with universities and not with PRIs.

For the second hypothesis, that interactions with PRIs would be more likely to have a focus on short-term effects, we found no evidence to support it.

This result is quite interesting. Indeed, a failure to establish that linkages with PRI are more likely than linkages with university to be focused on short-term effects may even seem remarkable, in the sense that it refutes
the idea that PRIs focus on application-oriented projects with a limited

time-perspective and thereby have a special ‘niche’ in the systems of PROs.

From the firm perspective, PRIs do not prove more focused on short-term
effects and development projects than universities.

A possible interpretation is that the results of our empirical test show
that the organizations involved do not correspond to the stylized view of
the institutional differences between the two types of PRO, which we call
universities and PRIs throughout the text. One possibility is that the PRIs
that firms engage with are quite similar to universities, bearing in mind
that certain PROs may share the rules, norms and incentives of universi-
ties, but not be HEIs (e.g. the Max Planck Society of Germany or the
CNRS of France). However, we do not find this interpretation plausible
in this empirical context. Our pre-understanding, seemingly corroborated
by our survey data and additional data collected (see the Appendix), is
that in the empirical setting that we have chosen for our test – the Swedish
engineering industry – the relevant domestic and most frequently engaged
foreign PRIs fit our assumption of institutional differences quite well. The
PRIs reported as partners are not very focused on research. Hence the
other and perhaps more plausible interpretation is that firms are able to
use contacts with individual university-based researchers for application-
oriented projects, thereby increasing the degree of control that the firm
can exercise over the project (Antonelli, 2008).

Our results thus indicate interesting directions for future research as
well as implications for public policy, as regards the division of labour
among different types of PROs.

One key question is: Should universities be encouraged to orient their
contacts with firms more towards research and further away from offer-
ing assistance in firms’ short-term R&D ambitions? Previous research has
indicated that star researchers may be able to publish, patent and commer-
cialize their ideas (Zucker et al., 1998). However, while engagement with
industry in general is neither negatively nor positively related to academic
excellence (D’Este et al., 2013), activities such as extensive consulting
engagements of university faculty are negatively related to the quality of
research output (Rentocchini et al., 2014). This suggests that universities
may be well advised to consider carefully what types of relationships to
industry they should seek to develop – and which relationships should be
actively discouraged.

Another question is: Should PRIs be encouraged more actively to orient
their contacts with firms towards applied, short-term R&D, so as more
clearly to accentuate their complementarity to universities? Would closer
integration between PRIs and universities facilitate such a development?
The question of how to (re-)organize public research (e.g. merging public
Innovation and entrepreneurship in the global economy

Innovation and entrepreneurship in the global economy

labs, establishing closer connections between labs and universities) has been on the innovation policy agenda for at least a decade, and remains hotly debated in many European countries (Preissl, 2006). The PRI model of PRO has been dismissed as providing ‘a small fraction of the total amount of positive externalities that [universities] are able to provide’ (Foray and Lissoni, 2009).

Systematic studies relating the role of PROs for effectiveness in terms of research and innovation output are, however, only just emerging. To our knowledge, this is the first empirical assessment of whether the two parallel systems of PROs (universities and PRIs) serve different functions as collaboration partners for industry. Therefore our result that, on balance, only limited evidence could be found that PRIs complement universities, is relevant to this debate. Since an assumption of complementarity underlies the funding rationale for this sector, we believe that these findings call for further research, for example to investigate other models of how PRIs complement universities in systems of innovation.

NOTES

1. Collaboration with PROs also serves a wider set of purposes, more indirectly related to innovation outcomes. Examples of such purposes, which are outside the scope of this chapter, are related to recruitment, access to international networks and access to public co-funding (Broström, 2012).

2. Throughout the chapter, we use the term ‘universities’ to characterize all higher education institutions (HEIs). However, it should be noted that, in the survey, the term ‘higher education institutions’ was used. In Sweden, as well as in many other countries, the term ‘university’ refers only to the most research-intensive HEIs.

3. This theoretical problem is replicated in the data, as shown using an ordered probit approach with sample selection correction, evaluated using the ssm wrapper for the gllamm program in STATA (Rabe-Hesketh et al., 2002).

4. While the probit model with sample selection is a consistent estimator, simulation experiments have shown that difficulties in numerical maximization may induce bias in the estimates (Freedman and Sekhon, 2008). To control this kind of bias and ensure the robustness of our results, we have estimated our model with both the built-in implementation of the estimator in STATA (heckprob), and the alternative implementation of the estimator given by Miranda and Rabe-Hesketh (2006). The results, which are available on request, show some differences in estimates of control variables, but all results of relevance to our hypotheses are unaffected by the choice of estimator implementation. Tables 2.4 and 2.5, report results from the standard implementation of the estimator.

REFERENCES


APPENDIX CHARACTERIZATION OF THE THREE MOST FREQUENTLY CITED INSTITUTES

In the survey utilized in this chapter, firms were asked to identify with which institution they collaborated. Among Swedish PRIs, a large majority of answers referred to the three institutes SWEREA, SICS and SP. Table 2A.1 provides key figures on these institutions.

The results under number of articles is the outcome of a search on the Science Citation Index Expanded (SCI-EXPANDED) database of the ISI Web of Science for the years 2005–07.

Relatively low publication frequencies are mirrored by significant levels of private ownership and private funding.

Note that we conducted the same search on publications data for all universities that were listed as ‘most valuable partner’ by at least five respondents. The three most cited universities have over 5500 articles and just below 5800 employees (full-time equivalents) in their faculties of science and/or technology. A search of the Max Planck Institutes in Germany, which are oriented towards basic scientific research and employ about 13 000 people, produced over 18 000 articles using the same search criteria as those applied above.

Together, these figures suggest that the institutes that firms refer to in our survey are mainly ‘non-academic’, and as such have a different profile in terms of incentives, culture and institutional set-ups than might be expected in a university.

Table 2A.1 Key figures on the three dominant Swedish PRIs

<table>
<thead>
<tr>
<th></th>
<th>Private ownership (%)</th>
<th>Private funding (%)</th>
<th>Number of employees</th>
<th>Number of articles 2005–07</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWEREA</td>
<td>51</td>
<td>55</td>
<td>280</td>
<td>60</td>
</tr>
<tr>
<td>SICS</td>
<td>40</td>
<td>25</td>
<td>100</td>
<td>7</td>
</tr>
<tr>
<td>SP</td>
<td>0</td>
<td>70</td>
<td>570</td>
<td>48</td>
</tr>
</tbody>
</table>

Sources: Annual reports; ISI Web of Science. Data in the first three columns are for 2007.
3. Technological advancement through imitation by industry incumbents in strategic alliances

Nerine Mary George, Sergey Anokhin, Vinit Parida and Joakim Wincent

1. INTRODUCTION

Strategic technology alliances between established players and startup firms as well as alliances among incumbents that aim at technological advancement are a common occurrence (Kogut, 1988; Bosse and Alvarez, 2010; Grant and Baden-Fuller, 2004; Colombo et al., 2006). It is believed that startups choose to engage in such alliances to extract unique value not available to them individually, which helps them overcome the liability of newness and smallness (Rothaermel, 2001; Bianchi et al., 2011; Parida et al., 2012). This includes getting access to resources, channels for market entry and gaining legitimacy (Baum et al., 2000; Shan et al., 1994; Walter et al., 2006; Colombo et al., 2006; Gentry et al., 2013). Incumbents, in turn, pursue their own agenda when collaborating with their peers and startups, and mainly look for opportunities to advance their technological development by learning – and appropriating – new ideas from partners (Dushnitsky and Shaver, 2009; Wales et al., 2013). Thus collaborations of this nature are always permeated by the fear of technological imitation or opportunistic behavior. As we demonstrate in this chapter, such fears are not unfounded: it appears that at least some incumbents engage in heavy imitation to boost their total factor productivity, and it also seems that they choose to misappropriate novel ideas from the weaker partners – startups that cannot necessarily guard and protect themselves against such misappropriation.

Extant literature provides evidence that firms learn when they engage in technological alliances (Tripsas, 1997; Rothaermel, 2001; Christensen et al., 2005; Zhang and Baden-Fuller, 2010) although the transfer of knowledge is claimed to be very hard due to knowledge ‘stickiness’ (Szulanski, 1994). Nevertheless, it is obvious that incumbent firms benefit from
working closely with startups across various industrial settings, including the typesetting industry (Tripsas, 1997), consumer electronics (Christensen et al., 2005), pharmaceutical firms (Rothaermel, 2001) and biotechnology (Rothaermel and Deeds, 2006). They are also said to imitate their fellow incumbents across a wide selection of industries to improve their own productivity drastically (Schnaars, 1994). Yet little is known about who stands to benefit most from imitation, conditions that make imitation more or less likely, and the pools of knowledge within which imitators typically search for such opportunities.

Although recent literature touts the benefits for leading industry firms of ‘imperfect imitation’ for advancing productivity and performance (Posen et al., 2013), we believe that organizational inertia and the presence of core rigidities (Hannan and Freeman, 1984) as well as the incumbent’s curse (Chandy and Tellis, 2000) among industry front-runners are likely to restrict the probability of knowledge transfer to such incumbents from their partners. Instead, we suggest that technological laggards who have unsophisticated and outdated technologies are more inclined to imitate and exploit complementary and substantive technologies of their alliance partners. Specifically, such imitative knowledge transfers on the part of lagging incumbents are likely to target startup firms and not their fellow incumbents because younger and smaller firms are less likely to engage in retaliatory actions; indeed, they may lack the ability to recognize the full potential of the technologies they hold due to insufficient experience, absorptive capacity or limited background of key employees (Anokhin et al., 2011).

We show that the rates of improvement in total factor productivity are higher for firms with substantial opportunities for technological imitation. Furthermore, such improvements are probably attributable to imitation rather than innovation because the relationship between room for imitation and total factor productivity change is stronger where appropriability regime is weak. Specifically, effectiveness of lead time as a means of ensuring appropriability significantly affects this proposed relationship. This is very much in line with the prediction of Cohen et al. (2000) regarding conditions that foster technological opportunism, and is also consistent with the recent work by Dushnitsky and Shaver (2009). Our evidence also suggests that incumbents are likely to source their imitative opportunities from smaller firms and not other incumbents. This has direct managerial implications for small and large firms alike.

Our results come from a custom-built multi-year, multi-industry dataset. They contribute to the literature in several ways. First, we extend the literature on strategic alliances by providing evidence that incumbents secure technological competitiveness through imitation. Our results suggest that
incumbent inertia and core rigidity are perhaps among the more significant safeguards that startups need to rely on in alliances with incumbents. Second, we contribute to the literature on appropriability regimes by suggesting that lead time to market is an important determinant of the opportunistic behaviors of incumbents when it comes to imitating technological know-how. Finally, our results suggest novel guidelines for startup firms seeking to align with incumbents: it appears that, to avoid losing their technologies to incumbents, startups should steer clear of technological laggards who may often offer more attractive partnering terms and instead go for the industry leaders.

2. CONCEPTUAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

Room for Imitation and Technological Advancements

Technological advancement is commonly believed to be the prerogative of industry leaders who define the production frontier. Front-runner incumbents have effective and sophisticated technologies and are said to use key resources and other inputs most effectively to produce value (Kogut, 1991; Sirmon et al., 2007). In fact, because such front-runners define the technological frontier in their respective industries, it is both natural and borderline tautological to expect that they also outperform others in improving their total factor productivity.

Moreover, recent simulation-based evidence suggests that not only do such leaders do well by developing complex technologies that could endow them with sustainable competitive advantage (Rivkin, 2000), but they also stand to gain much by imperfectly imitating other, less effective companies (Posen et al., 2013). In fact, they are often portrayed as a threat to alliance partners and startups with innovative technologies (Hamel, 1991; Baum et al., 2000). The literature documents several examples where front-runner incumbents misappropriate or otherwise sabotage the technologies owned by their smaller counterparts. Microsoft Corporation, for instance, is even claimed to be perceived as the ‘ogre to the north’ in the high-tech startup community precisely because of such behavior. Similar behaviors are commonplace across different industries (Anokhin et al., 2011).

Yet when it comes to making predictions regarding the speed of technological advancement, front-runners are not likely to top the list for several reasons. Although front-runners are those likely to push the frontier for the entire industry and thus to create opportunities for imitation by others (Hagedoorn, 1993; Ahuja, 2000; Stuart, 2000), they
themselves have no or very limited room to imitate other companies. This implies that they have few options for cheaper copying and would need to commit significant investments in innovation efforts and R&D to ensure improvement. Moreover, although imitating less advanced counterparts may actually turn out to be a very attractive avenue for increasing productivity (Posen et al., 2013), front-runners are plagued by incumbent inertia (Hannan and Freeman, 1984) that may manifest itself in two types of rigidity: resource rigidity and routine rigidity (Gilbert, 2005, p. 741). Both impede incumbent firms from imitating disruptive technologies and thus make the technological advancement available to them through imperfect imitation (Posen et al., 2013) unlikely to happen. Resource rigidity is the ‘failure to change resource investment pattern’ (Gilbert, 2005, p. 741), where resources include human, financial and production. Routine rigidity is the ‘failure to change the organizational processes that utilize those resource investments’ (ibid.). Both types of inertia are a result of previous and current success, whereby incumbents with a strong technology position are unable to enact internal technological changes in the face of significant external technological change (Miller and Friesen, 1980; Romanelli and Tushman, 1994). As a result, forces of inertia within incumbent firms with frontier technology facilitate ignorance of competing technologies, inhibit incumbents’ ability to absorb, adapt and use their internal resources to build on alternatives and thus to secure productivity and competitiveness even after sighting a potential opportunity to imitate in alliances¹ (Hill and Rothaermel, 2003). Similarly, front-runners are known to suffer from the ‘not-invented-here’ syndrome, a human resource rigidity that is rooted in the mindset of individuals within organizations who see their technological solutions as superior, which undermines trust in externally acquired technologies (Katz and Allen, 1982). This results in a situation akin to the ‘incumbent’s curse’, as argued in Chandy and Tellis (2000). It has also been suggested that fear of cannibalizing economic returns from existing technologies is a financial resource rigidity that inhibits front-runner incumbents from imitating others’ technologies (Nijssen et al., 2005) and thus may limit their rates of technological advancement.

In contrast, technological laggards are not likely to suffer from these same shortcomings. Because imitation is generally easier than innovation (often, there are risks but not uncertainty), imitative opportunities are likely to motivate strategic moves of incumbents and thus lead to technological advancement at unprecedented rates. Here, the opportunity to imitate technology simply refers to the potential to improve technology by copying and building on emerging and existing technologies (Bae and Lee, 1986; Kogut and Zander, 1992; Anokhin et al., 2010). Although laggards
are relatively unlikely to come up with improvements that shift the frontier for their industries and thus create new opportunities for everybody, they are advantageously positioned to improve their own resource combination productivity by imitating others. As such, from a purely pragmatic point of view, laggards with substantial imitative opportunities may demonstrate superior growth rates of total factor productivity in as much as the gap with front-runners remains. Catching up to the new frontier by laggards may happen at a much faster pace than trailblazing by the front-runners. To state this formally:

\[ H1: \text{ Availability of imitation opportunities is positively related to the rates of technological advancements exhibited by established corporations. } \]

The Moderating Role of Appropriability Regime

If our conceptual development is sound, additional insights into the rates of technological advancement may be obtained by studying the effects of industry appropriability regimes. Appropriability regimes (i.e. patent protection, secrecy and lead time; see Cohen et al., 2000) have been suggested as an important factor in effecting technological alliances (Teece, 1986; Levin et al., 1987). Gulati and Singh (1998) argue that whenever knowledge-intensive considerations are involved (as is the case with technology-based alliances), partners are acutely aware and concerned about appropriability compared to alliances without technology component. This observation provides a possibility to deepen our understanding of the sources of technological advancement.

If technological advancement of incumbents comes primarily from creating new technologies, one should expect an industry appropriability regime to facilitate incumbents’ own efforts at pushing the technological envelope. Indeed, they should more willingly invest their efforts in improving current technologies when they know that they can retain a major portion of the value so created. If, on the other hand, our initial hypothesis is correct, and laggards are those most likely to demonstrate superior growth rates due to imitation, the strength of the appropriability regime should negatively affect the rates of improvement that could be attributed to imitation. Instead, such growth is likely to happen where the appropriability regime is weak. When incumbents’ technologies are obsolete and internal resources generate limited value, they have a higher motivation to act opportunistically because of their survival instincts. A weaker appropriability regime makes such opportunistic actions more feasible (Koellinger, 2008). In short, the influence of imitation opportunities available to incumbents with respect to improvements in technologies
should be stronger when the appropriability regime is weak. To state this formally:

\[ H2: \text{Strengths of the appropriability regime (effectiveness of patents, trade secrets and lead time in warding off imitation) negatively moderate the relationship between imitation opportunities and rates of technological advancements.} \]

**Source of Imitation Opportunities**

If indeed major opportunities for growth come from imitation, and if such imitation is more effective when appropriability regimes are weak, the question naturally arises as to where exactly incumbents source their opportunities for imitation. There are two potential pools where such opportunities can be sought: fellow incumbents who are closer to the frontier than the firm in question; and startup firms that may have technologically advanced (but perhaps untested) ideas. Although the choice between these two pools of imitation opportunities has not been studied specifically, the extant literature accepts both as valid. Many studies implicitly assume that incumbents will try to imitate advanced technologies owned by other incumbents (e.g. Rivkin, 2000, 2001) and that such imitation may be highly attractive (Posen et al., 2013). Others point to incumbents’ tendency to misappropriate technologies developed by startups (e.g. Dushnitsky and Lenox, 2005; Dushnitsky and Shaver, 2009).

Parkhe (1993) argues that opportunism is neither widespread nor sporadic in any industry. Due to a short-term view on technology alliances, incumbents prefer to form partnerships with new entrants or startups in close proximity to them. These are viewed as easy targets by incumbents as they have fewer resources to orchestrate protection. Based on Schumpeter’s (1942) seminal arguments, incumbents are more likely to exert greater influence over startups (Dyerson and Pilkington, 2005) and are thus more likely to act opportunistically when teaming up with small and young firms (Morgan and Anokhin, 2012). Startups are generally in a vulnerable position compared with incumbents because of their need for complementary resources, and are thus less likely to call the incumbent to justice if the latter ‘misbehaves’. Lagging incumbents may see such startups as a source of technologies to propel them closer to the frontier, and at the same time may not fear retaliation much because of the vast difference in scale and amount of resources each of the partners may marshal to wage a legal battle should technology misappropriation be discovered by the startup (Morgan and Anokhin, 2012). This is in contrast with other incumbents that are likely to engage in costly and lengthy legal disputes.
when they feel their rights are violated, as the recent series of litigations between Apple and Samsung demonstrates.

It is also important to note that the survival rate of startups is low (Giarratana, 2004) due to their lack of experience in the market and lower operational slack (Azadegan et al., 2013). Accordingly, to ensure survival, startups may seek cooperation with incumbents in search of complementary assets (Colombo et al., 2006) and assistance with market entry (Burgel and Murray, 2000), even if they suspect and expect foul play on the part of the incumbent. Thus, when supply of relatively weaker startups is sufficient, a rational incumbent who lags behind the frontier is likely to imitate such startups and not front-runner incumbents who are likely to fight back vigorously. To state this formally,

\[ H3: \text{ Incumbents are more likely to source imitative opportunities from startups and not from other incumbents.} \]

3. METHOD

3.1 Data

To study the questions posed by this study we compiled a dataset of public companies across 26 different industries that varied in terms of their technological prowess and strategies employed to exploit opportunities for imitation. The criteria for inclusion in the dataset were as follows: (a) the companies had to be public to ensure coverage by Compustat; (b) the companies had to have formal links to startups established and documented by the two most authoritative sources of information on such partnerships: the AssetAlternatives’ Corporate Venturing Directory and Yearbook (this reduced the sample to 218 corporations) and the SDC Platinum’s VentureXpert (further sample reduction to 180 corporations). Besides, eight more corporations were omitted as they represented industries that are typically excluded from such studies (e.g. finance and insurance; real estate, rental and leasing), bringing the sample size down to 172 corporations. Missing values in the variables of interest accounted for the final reduction of the sample to 153 corporations.

Over the course of the years for which the data were gathered, two-thirds of the firms in our dataset participated in equity-based partnerships with small technologically oriented companies that they could tap into as a source of new ideas. Eighty percent of corporations in the dataset also had formal connections with other incumbents interested in technological gains that could also be seen as a potential source of ideas to imitate.
Most variables collected were gathered from Compustat. The information on partnerships between incumbents and startups, as well as the information on connections between incumbents that could facilitate imitation, has been accessed via SDC Platinum dataset and the directories published by AssetAlternatives. Various measures of appropriability regime have been borrowed from Cohen et al. (2000). These measures are based on a large-scale survey conducted in the mid-1990s by Carnegie Mellon University and are largely consistent with the earlier estimates reported by Levin et al. (1987) from Yale University. The merger of the various data sources has predetermined the time window: while Compustat and SDC Platinum provide continuous data coverage, AssetAlternatives is limited to the 1998–2001 period, and the appropriability estimates reported in Cohen et al. (2000) were collected in the 1990s. As such, our final data cover the period from 1998 to 2001.

3.2 Variables

3.2.1 Dependent variables
To study the direct and moderated effects of the availability of imitation opportunities on the rates of technological advancement we employed Malmquist productivity index decomposition – a technique that allows us to estimate total factor productivity change (Malmquist, 1953). Based on the recommendations of Hollingsworth (2004), the DEAP computer program has been employed to obtain the estimates (Coelli, 1996). Total factor productivity change has been used extensively by the prior research to assess technological advancement (Nadiri, 1970; Nishimizu and Page, 1982; Colino et al., 2013; Anokhin and Wincent, 2012). Values of total factor productivity change exceeding 1 indicate that the technologies currently employed by the focal firm are superior to those employed in the previous year. Values below 1 indicate that a technological regress took place and the technologies are less advanced than those used previously. The data required to calculate total factor productivity change were sourced from Compustat.

To study where incumbents source their imitation opportunities, we analyzed the degree to which they are implicated in intellectual property disputes. We used LexisNexis Academic database to compose this variable (Anokhin et al., 2013). Overall, we collected a total of 2791 lawsuit observations for the firms included in our dataset for the period from 1997 to 2001. We split the lawsuits into pertinent and non-pertinent. The pertinent group comprised lawsuits pertaining to trademarks, copyright infringement, licensing and patents. A total of 430 observations qualified for inclusion in the group; the rest of the cases were non-
pertinent (e.g. labor disputes). Of the pertinent cases, 289 were defendant observations; that is, they represented cases where legal action due to misappropriation/imitation was brought against the incumbents. These formed the basis for the analyses reported in this chapter.

3.2.2 Independent variables and moderators
We estimate the availability of opportunities for imitation with the help of the minimum performance inefficiency (MPI) technique that has been recommended for the study of inefficiency in the industrial context by Anokhin et al. (2010). While mathematically the method is rather involved, the intuition behind it may be summarized as follows. In each of the 26 narrowly defined NAICS-based industries, the technique compares the efficiency with which companies combined resources (labor and capital) to produce outputs (sales). The narrow definition of industries is important to ensure the comparability of production functions employed by the firms. Because we have multi-firm, multi-year data, we needed to incorporate the temporal nature of the data into our calculations. We do so with the help of the intertemporal formulation of the efficiency estimation approach (Tulkens and Eeckaut, 1995), which fixes the slope of the production frontier. Anokhin et al. (2010) suggest that opportunities for technological imitation exist because markets are inefficient and do not adjust instantaneously to changing realities, which is then reflected in inefficiency of each firm compared with the industry leaders.

As is the case in Anokhin et al. (2010), in most industries the frontier is determined by one or two companies, with others trailing behind with various degrees of proximity. After establishing the production frontier in each industry, the room for imitation is estimated by capturing the distance of each corporation from its respective frontier year after year. It is believed that this distance is proportionate to the availability of opportunities for imitating the industry’s best firms that the focal corporation has. Importantly, this approach allows capturing room only for imitation of superior technologies and does not assess the likelihood of technological advancement due to purposeful imitation of companies’ technologies with less efficient (inferior) ones pursued by other industry players. The mathematical programming models were solved using Frontline Systems’ Premium Solver for Microsoft Excel, as explained in Anokhin et al. (2010). Due to high mathematical complexity, we do not explain the derivation of the formulae here, but refer the reader to the original work by Anokhin et al. (2010). The data necessary for producing the estimates came from Compustat.

The measures of the three aspects of the appropriability regime – the effectiveness of patents, secrecy and lead time as means to ward off
imitators – were borrowed directly from the work of Cohen et al. (2000). The estimates reported in Cohen et al. (2000) are based on the percentage of innovations for which the respective mechanisms (patents, secrecy and lead time) were deemed effective by the firm R&D and intellectual property specialists (1478 R&D labs in various industries were surveyed to obtain these estimates).

Involvement with growth-oriented technological startups (startup partnership intensity) that was hypothesized as a source of opportunities for imitations that the incumbent could tap into was operationalized as the number of distinct startups that the corporation supported in exchange for equity stakes in any given year. The information came from SDC Platinum and from AssetAlternatives directories. Finally, to estimate the extent to which a focal firm was connected to other incumbents that could have become a source of opportunities for imitation, we analyzed incumbent networks that the focal firm was involved in and that could have been used as a de facto forum for idea exchange. By using social network analysis we assessed closeness centrality of the focal firm to other incumbents that participate in such idea exchange networks (Anokhin et al., 2011). Closeness centrality allows us to estimate the shortest distance of the focal firm to all other network members and is beneficial when one needs to gauge the expected time required for an incumbent corporation to transmit and access information and valuable knowledge in a network (Borgatti, 2005). We used UCINET software to capture this variable.

3.2.3 Controls
First, to contextualize the impact of the opportunities for imitation on the technological advancement of corporations, we have taken into account the industry-average imitation opportunities. Because the strategy of the firm is developed in close awareness of other firms in the industry, we calculated this measure for all public firms operating in the same industries as the focal firms and averaged the estimates for each of the 26 industries involved in our analysis. Overall, 10650 firm-year observations were analyzed and processed.

We also control for organizational size (Dushnitsky and Lenox, 2006) and organizational slack (Chesbrough and Tucci, 2004). We operationalized the former as the log of sales, as is common in the literature, and the latter as the current ratio of assets to liabilities of the incumbent corporation (Singh, 1986). It was also deemed important to control for industry-patenting propensity as it may bear on the incumbent’s being implicated in intellectual property disputes. We operationalized industry-patenting propensity as a dummy variable that equaled 1 if the corporation belonged
Technological advancement through imitation

We further controlled for the risk preference of incumbents. Many corporate investors prefer to invest in late-stage ventures because the technology is already known and has been shown to work; thus the risk of not getting the strategic benefits that the incumbent pursues is substantially reduced (Ernst and Young, 2002; Fredriksen and Klofsten, 2001). For this reason we controlled for the preferred stage of investment with the dummy variable risky equity investments that equals 1 if the incumbent prefers to invest in seed and early-stage ventures and 0 if it invests in later stages. The variable was derived from AssetAlternatives.

Because the availability of opportunities for imitation may be reduced when new entrants flood the industry, we controlled for the net business entry rates. This measure is typically used when the information on new entrants as such is not available (Chang et al., 2011; Anyadike-Danes et al., 2005; Bosma et al., 2011). Specifically, net startup rate in year \( t \) was defined as the ratio of the difference in the stock of active businesses in year \( t \) and \( (t - 1) \) to the stock of active firms in year \( (t - 1) \). Thus, to estimate the startup rate in 1999 we divided the difference in the number of active firms between years 1999 and 1998 by the number of active firms in year 1998. We used US Census Bureau data to compile this variable.

We controlled for the industry concentration ratio conceptualized as four-firm industry concentration (i.e. the market share of the four largest firms within their four-digit NAICS industries). The variable was computed based on the information from the Compustat database. This measure has been commonly and successfully adopted in previous studies to indicate the degree to which an industry is oligopolistic and the extent of market control held by the four largest firms in the industry (Chuang and Lin, 1999; Dean and Meyer, 1996; Kock and Santalo, 2005). The concentration ratio may vary from a low of 0 percent to a high of 100 percent, where 0 percent demarcates an extremely competitive market and 100 percent implies an extremely concentrated oligopoly or even monopoly situation.

Finally, we controlled for whether or not focal corporations take seats on the board of technological startups they support, as reported by AssetAlternatives. The policy of taking seats is becoming more common: while about one-third of incumbents took seats on new ventures’ boards in the late 1990s, over half of incumbents had instituted such policies by the end of 2000s (Ernst and Young, 2002, 2008–09; MacMillan et al., 2008). Because the boards could be seen as de facto forums where idea exchange between the new venture and its investors occurs, highly involved incumbents try to take a seat (voting or non-voting) on their
investees’ boards. The variable is coded as a dummy where 1 indicates that the incumbent has an explicit policy of taking seats on their investees’ boards and 0 indicates that such policy is not established.

4. ANALYSIS

Overall, we estimated four different models. Models 1–3 used total factor productivity change as a dependent variable; Model 4 used pertinent intellectual property-related lawsuits as a dependent variable. Model 1 includes control variables. Model 2 adds the availability of imitation opportunities to the set of predictors. Thus it tests Hypothesis 1 – whether companies that have ample opportunities for imitation make use of them and improve their total factor productivity change more than companies that have little if any opportunities for imitation. Model 3 adds the three dimensions of the industry appropriability regime as well as including interaction effects of those terms with the availability of opportunities for imitation. It thus tests Hypothesis 2, and provides additional corroboration to our conjecture that firms imitate know-how developed elsewhere when it is not guarded strongly by the industry appropriability regime. Model 4 recreates Model 3 but uses pertinent lawsuits as a dependent variable. Thus it tests Hypothesis 3 and investigates whether the focal firm’s involvement with incumbents or startups is a source of the opportunities it imitates.

Because our data are panel in nature, we could not use OLS estimation and needed to engage proper econometric techniques. After careful consideration we chose to rely on the random effects GLS regression in Models 1–3 while correcting for AR(1) disturbances in standard errors. Because the dependent variable in Model 4 is count in nature, that model was tested with a population-average negative binomial estimation, similarly corrected for the AR(1) disturbance. Negative binomial and not the Poisson approach was chosen to ensure conservative estimates due to overdispersion. To avoid non-essential ill-conditioning, all predictor variables were standardized (Marquardt, 1980). Descriptive statistics and the correlation table for the variables included in this study are presented in Table 3.1.

5. RESULTS

All models (Table 3.2) are significant and demonstrate acceptable fit. Moreover, they exhibit incremental improvement with the addition of the
Technological advancement through imitation

hypothesized relationships. Model 2 is significantly better than Model 1 ($\Delta \chi^2(1) = 258.15, p < 0.001$). Model 3, in turn, is better than Model 2 ($\Delta \chi^2(6) = 22.04, p < 0.01$). Model 4 is highly significant as well (due to a different dependent variable employed, no chi-square difference test is performed; the model itself is significant at $p < 0.001$). Our analyses lend support to the hypotheses advanced in this study. Indeed, Hypothesis 1 is supported by Model 2: the availability of opportunities for imitation is positively related to the rates of technological advancement ($\beta = 0.306, p < 0.01$). Similarly, Hypothesis 2 is supported for one of the indicators of the appropriability regime (effectiveness of lead time negatively moderates the relationship between the availability of opportunities for imitation and the rates of technical advancement ($\beta = -0.104, p < 0.05$) but not for others. Hypothesis 3 is supported as well: although the degree of involvement with other incumbents does not exert an effect on the likelihood of being implicated in an intellectual property dispute as a defendant, the degree of involvement with startups is positively significantly related to this dependent variable ($\beta = 0.357, p < 0.01$). This helps explain why, of the three mechanisms that constitute appropriability regime, only lead time is significant when it comes to moderating the relationship between imitative opportunities and advancement in technologies: startups may not have the resources to patent their ideas (and so patent protection effectiveness does not play the role assigned by the theory), and it may be problematic to maintain secrecy, given the close involvement of most incumbents with their smaller technologically oriented equity partners (importantly, although non-significant, the sign of the coefficient for the effectiveness of secrecy is negative, as expected: $\beta = -0.672$).

6. DISCUSSION

In this chapter, we investigate the effect of imitative opportunities on technological advancement experienced by industry incumbents. We show that those with ample opportunities for technological imitation do better at improving their technologies than incumbents close to the technological frontier. Our conceptual development attributes such improvements to the beneficial effects of alliances between incumbents and startups. The extant literature agrees that such alliances are important for helping incumbents achieve competitiveness (Baum et al., 2000; Walter et al., 2006; Koza and Lewin, 1998). We provide novel insights for some of the paths through which this could happen.

Although conventional wisdom suggests that industry front-runners should experience higher rates of technological advancement compared to
### Table 3.1 Descriptive statistics and correlation table

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**Note:** *** $p < 0.001$; * $p < 0.05$; ** $p < 0.01$; † $p < 0.10$. 

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<td>0.08†</td>
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### Table 3.2 Regression results

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<tr>
<th>Dependent variable</th>
<th>Rate of technological advancements</th>
<th>IP disputes</th>
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<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>Startup partnership intensity</td>
<td>0.03</td>
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<tr>
<td></td>
<td>(0.02)</td>
<td>(0.02)</td>
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<tr>
<td>Incumbent network centrality</td>
<td>−0.00</td>
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<tr>
<td></td>
<td>(0.02)</td>
<td>(0.02)</td>
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<td>Industry-average imitation opportunities</td>
<td>0.02</td>
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<tr>
<td></td>
<td>(0.03)</td>
<td>(0.03)</td>
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<tr>
<td>Organizational size</td>
<td>−0.09**</td>
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<td></td>
<td>(0.02)</td>
<td>(0.02)</td>
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<td>Organizational slack</td>
<td>−0.04†</td>
<td>−0.03†</td>
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<td></td>
<td>(0.02)</td>
<td>(0.02)</td>
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<tr>
<td>Industry-patenting propensity</td>
<td>−0.01</td>
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<tr>
<td></td>
<td>(0.02)</td>
<td>(0.02)</td>
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<tr>
<td>Risky equity investments</td>
<td>−0.02</td>
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<td></td>
<td>(0.02)</td>
<td>(0.02)</td>
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<tr>
<td>Business entry rates</td>
<td>0.07*</td>
<td>−0.03</td>
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<td>Industry concentration ratio</td>
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<tr>
<td>Seats</td>
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<td>(0.02)</td>
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<tr>
<td>Availability of opportunities for imitation Patents effectiveness</td>
<td>0.31**</td>
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<td></td>
<td>(0.02)</td>
<td>(0.05)</td>
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<tr>
<td>Secrecy effectiveness</td>
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<td></td>
<td>(0.09)</td>
<td>(0.81)</td>
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<td>Lead time effectiveness</td>
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<td>(0.03)</td>
<td>(0.22)</td>
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<tr>
<td>Opportunities for imitation × Patents</td>
<td>0.27</td>
<td>−2.90</td>
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<td>(0.17)</td>
<td>(2.40)</td>
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<td>Opportunities for imitation × Secrecy</td>
<td>−0.09</td>
<td>0.84</td>
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<td>(0.24)</td>
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<td>Opportunities for imitation × Lead time</td>
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<td>0.318</td>
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<td>(0.05)</td>
<td>(0.54)</td>
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<td>Constant</td>
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<tr>
<td>R-squared</td>
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<td>Adj R-squared</td>
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<td>0.30</td>
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<tr>
<td>Wald χ²</td>
<td>χ² (11) = 41.73</td>
<td>χ² (12) = 299.88</td>
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<tr>
<td>Δχ²</td>
<td>Δχ² (1) = 258.15</td>
<td>Δχ² (6) = 22.04</td>
</tr>
<tr>
<td>Probability</td>
<td>p &lt; 0.001</td>
<td>p &lt; 0.01</td>
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**Notes:**
- Standard errors in parentheses.
- *** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.1.
Technological advancement through imitation

laggards, our conceptual development offers diverging predictions. While we believe in the important role of industry incumbents in pushing the frontier and creating new opportunities for all industry members, at the individual firm level it is firms with ample imitation opportunities that appear to improve technological productivity most. Thus they could be seen as rapidly improving through imitation – a strategy consistent with the advice derived from a simulation-based study by Posen et al. (2013). At the same time, front-runners, who stand to benefit greatly from purposely managed imitation, are apparently reluctant to go this route. The reasons may include multiple rigidities – resource and routines – and overall the situation is consistent with the phenomenon of the incumbent’s curse described in the work of Chandy and Tellis (2000).

The fact that such improvements in productivity occur mainly in industries with weak appropriability regimes lends further support to our conjecture that imitation and not innovation is the primary way of technological advancement experienced by the lagging incumbents. Otherwise, one would have seen technological advancement happening exclusively in industries where innovation is strongly protected against misappropriation. In fact, the opposite is true, indicating that laggards improve when they can orchestrate knowledge spillovers from the more advanced parties (Anokhin and Wincent, 2014). When appropriability regimes are weak, the risks for incumbents due to misappropriating others’ developments are minimal (Gulati and Singh, 1998). Curiously, however, of the multiple mechanisms available to firms to safeguard their technological leadership, only lead time appears to ward off imitation. Neither the strength of patenting nor secrecy can prevent valuable knowledge from spilling over to industry laggards.

Finally, we explore the all-important question – whom do incumbents imitate? In principle, there are two pools of knowledge they can tap into: other incumbents and small technologically oriented startups. We offered arguments and found support for the idea that startups represent a more likely source of such imitation opportunities. It may be that, due to excess similarity of their market positions, fellow incumbents provide rather limited opportunities for radical restructuring of laggards’ operations, although the extant literature seems to provide counterarguments as well (Anokhin and Wincent, 2014). Those reasons notwithstanding, we find strong evidence of technological imitation of incumbents from startups. This imitation strategy is particularly appealing to incumbents due to ease of stealing from the weak startups compared to a similarly positioned incumbent – an argument reinforced by the observation that such imitation is more likely where appropriability regime is weak. Moreover, incumbents engaging in partnerships with startups are known to institute
a unique mechanism that makes such stealing easier – they take seats on the boards of startups they work with (Anokhin et al., 2011). By doing so, incumbents further solidify or increase their benefit.

Apart from underscoring the importance of imitation vis-à-vis innovation in facilitating technological advancement for incumbents, our study provides important implications for startups. Prior research has elaborated on the risks to startups of collaborating with incumbents. These are said to include unintended knowledge spillover that may affect the long-term survival of startups (Alvarez and Barney, 2001). Additionally, startups can lose control over their own resources (Forrest, 1990) and the cultural clashes between the startup firm and alliance partner(s) might curtail their ability to realize the true potential value of collaborations (Doz, 1988). Yet, currently the literature seems to suggest that startups should be wary of entering partnerships with industry leaders (Dushnitsky and Shaver, 2009). In sharp contrast, we provide evidence suggesting that it is actually the weaker, lagging incumbents that pose the maximum threat to startups in terms of their technologies being imitated away; front-runner incumbents do not appear to rely on imitation much, despite the benefits outlined by the extant research (Posen et al., 2013) – perhaps due to the desire to protect their reputation (Anokhin et al., 2013). Yet the benefits they provide to startups exceed those provided by the laggards. As such, startups seeking strategic benefits from collaboration with incumbents would be wise to look for strategic partners among leaders and not those trailing behind.

Like any other study, this one has certain limitations. First of all, we build it largely from the incumbents’ perspective, which provides limited insights into the nature of multi-firm partnerships. Further studies would gain from incorporating both startups’ and incumbents’ perspectives. Second, even though the data presented in this study are unique and extensive, and help to draw many useful conclusions, use of qualitative data could provide more insights regarding the mechanisms that drive opportunistic behavior of incumbents. Third, the use of estimates obtained with the help of efficiency estimation techniques in second-stage regression analysis is still a matter of considerable debate in the literature (see, e.g., McDonald, 2009). Thus, lacking independent validation, our results should be accepted with a degree of caution. Future research will benefit from other ways of capturing the rates of technological advancement or room for imitation. It will also be wise to consider recently developed bootstrap-based methods to deal with potential problems (see, e.g., Daraio and Simar, 2007). Fourth, our sample includes only firms that actively invested in startups during the specified period. Inasmuch as they are not representative of the overall population of firms, our results may
not be generalizable to the general population. Finally, we have not performed detailed cluster analysis of our data on front-runners and lagging incumbents due to limited observations. Future studies could explore the benefits of using different clusters of incumbents based on their technological superiority and market position, and relate this to their behavior towards technological alliances with startups and imitation strategies.

In conclusion, our results show that firms with plenty of opportunities to imitate grow faster in their productivity and this largely happens in the industrial setting with weak appropriability regimes. Moreover, established firms tend to prefer imitation from startups as opposed to copying other incumbents.

NOTES

1. It must be acknowledged, however, that being a front-runner probably endows a firm with a stronger position with respect to selecting partners (acquiring partners, establishing contracts or network arrangements with partners) to strengthen the innovation process of the firm, as reported in the extant literature. We would like to thank an anonymous reviewer for pointing this out.

2. The industries were as follows: Pharmaceutical industry, Information services, Software publishers, Computer related services, Consulting, advertising and related services, Semiconductor and electronic device manufacturing, Computer and peripheral device manufacturing, Pulp, paper and paperboard, Audio- and video communication equipment manufacturing, Telecommunications carriers, Chemical manufacturing, Utilities, Special equipment and instruments manufacturing, Electromedical and navigational equipment manufacturing, HR and staffing services, Retail trade, Industrial machinery manufacturing, TV, radio, cable services, Accommodation and food services, Food and drinks manufacturing, Hospitals and healthcare services, Courier services, Wholesale trade, Publishing industry, Air transportation, Automobile and truck manufacturing.

3. All active public companies in the respective industries have been analyzed. The overall number of firm-year observations analyzed was over 10,000. This ensured sufficient sample size in each industry to obtain accurate results.

4. We would like to express our gratitude to Todd Morgan for his research assistance with this task.

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Innovation and entrepreneurship in the global economy


Morgan, T. and Anokhin, S. (2012). ‘When the fog dissipates: the choice between
strategic emphases in a partner as a function of information asymmetry’, paper presented at the 2012 Summer American Marketing Association Conference.


4. Continuing corporate growth and inter-organizational collaboration of international new ventures in Sweden

Jan Abrahamsson, Håkan Boter and Vladimir Vanyushyn

1. INTRODUCTION

While the phenomenon and importance of international new ventures (INVs), firms that begin international operations soon after inception, are universally acknowledged, most of the extant research has been directed at uncovering factors behind such early internationalization and international success (Jones et al., 2011; Keupp and Gassmann, 2009). The domain of research on INVs stems from the field of international entrepreneurship (Oviatt and McDougall, 2005) and has been largely characterized by a focus on small and young ventures at the early stages of development (Jones et al., 2011).

Continuing growth and evolving managerial practices of INVs have been addressed to a much lesser extent (Zahra et al., 2006). After early success, continuing growth of an INV can be expected to depend on its ability to sustain the flow of innovations, both in products and business models, and its engagement in and configuration of collaborative relationships with various partners to facilitate such a flow. Consequently, calls for research in international entrepreneurship not exclusively focused on size and age of firms have emerged in recent years. Keupp and Gassmann (2009) pointed to the excessive focus of existing international entrepreneurship studies on small or very small firms, and highlighted that the phenomena of international entrepreneurship and international business should not be conditional on the size of the firm. Furthermore, INVs’ operations past inception and early growth are not well studied and have been identified among the main pathways to advance knowledge (Jones et al., 2011; Keupp and Gassmann, 2009).
Against this background, this chapter sets out to examine the scope and pattern of inter-organizational collaboration of INVs of different age, size and organizational form. International networks and various forms of inter-organizational collaboration have in past research been argued to heighten the initial speed of internationalization for INVs (Sharma and Blomstermo, 2003; Oviatt and McDougall, 2005; Laanti et al., 2007). At the same time, these collaborations could also enhance the entrepreneurial capabilities of INVs, due to assimilation of knowledge and information (Karra et al., 2008). By looking at the dynamics of INVs’ inter-organizational collaborations over time, this study will contribute to the literature on INVs’ continuing development past the early internationalization stage and on the role of inter-organizational collaboration in INVs’ ability to sustain competitive advantage and performance.

Past research on INVs has been dominated by conceptual work or qualitative case studies (Sapienza et al., 2006). Given that INVs are rather rare and each of those firms faces unique international settings, challenges and growth patterns, choices for in-depth studies have been clearly justified. Recently, there has been a surge in register-based quantitative approaches, for example Halldin’s (2012) studies of INVs in Sweden. However, even detailed register data generally do not contain the information needed to examine and assess constructs such as dynamic capabilities or cooperation scope – constructs that have been claimed to be of importance for INVs (Jones et al., 2011). To address this concern, in this study we complement longitudinal register data with survey-based information. Combined, these two sources allow us to examine the managerial practices of INVs and their continued international growth.

In making these contributions, our chapter begins with a review of existing research into INVs. In response to concerns we raise about the extant work, we develop a set of propositions for examining the collaboration practices of INVs. Propositions are tested using register-based data from the years 1998–2009 and the fourth wave of the Community Innovation Survey (2009). Our chapter ends by discussing the theoretical and managerial implications of our results and suggesting potential avenues for future research.

2. PRIOR RESEARCH

Research into rapid internationalization of firms has been ongoing since the early 1990s, and several concepts, sometimes used interchangeably, such as born global (Knight and Cavusgil, 1996), born international (Gabrielsson et al., 2004) or international new venture (Oviatt and
McDougall, 1994), have been used to describe and label these firms. One of the most widespread definitions is the one from Oviatt and McDougall (1994, p. 50), who defined an INV as ‘A business organization that, from inception, seeks to derive significant competitive advantage from the use of resources and the sale of output in multiple countries.’

An important facet of this definition is that it does not explain how the INV was created, or the size and age of the firm. Dimitratos and Jones (2005) also argue that subsidiaries of large multinational firms could serve as appropriate objects of study in the INV research context, as they could very well exhibit entrepreneurial and innovative behavior and thus also be in line with the Oviatt and McDougall definition of INVs proposed back in 1994. Spinoffs or subsidiaries of large firms have also, for instance, been studied in an explicitly INV setting by Dunford et al. (2010), who examined business model replication across international markets by a spinoff of a Canadian banking firm, labeling the spinoff an INV pursuing rapid international growth from its birth.

Irrespective of how an INV is formed, innovation could be argued to be a vital piece of the INV puzzle. First, INVs tend to be found in high-tech and knowledge-intensive industries, which are characterized by high dynamism in the business environment, thus making innovation an essential part of the competitive strategy in these types of sector. Innovation in this context refers to the firm’s ability to embrace creativity and experimentation in its internal processes, development and adoption of new technology as well as in product development (Lisboa et al., 2011). The characteristics of INVs often also fit quite well the description of firms participating in ‘open innovation’. A core argument in this discourse is that actors outside of the focal firm are vital for its innovativeness and continued competitiveness over time (Chesbrough and Rosenbloom, 2002; Teece, 2007).

Networking has been argued to be a source of innovative behavior in entrepreneurial firms in general. To specify, external relations with alliance partners, investors, key customers and suppliers, who may all possess key resources needed for innovation by the focal firm, could further spur innovation in the firm and thus may contribute to competitive advantage (Walter et al., 2006). In regard to innovation and what particular types of networks could enhance further innovation, Knight and Cavusgil (2004) highlight the opportunity for INVs to develop relevant capabilities in an international research partnership and then subsequently launch new international partnerships, geared towards commercializing the research-based innovation.

However, apart from scattered case-study-based evidence, there is little knowledge available regarding what actors INVs actually engage in inter-organizational collaboration with, and what is the international scope of
those collaborations. As these firms internationalize their operations soon after inception, INVs could then be suggested to have breadth in their networks not only in terms of various national actors, but also in terms of the international scope of the collaborations. In other words, INVs could be collaborating with a plethora of different actors in different countries/markets. Thus, below we develop a set of propositions on the issue, and specifically highlight the effects of a firm’s origin type and age on its evolving cooperation practices.

2.1 INVs’ Inter-organizational Cooperation and its Scope

Inter-organizational collaboration, in the form of networks, partnerships, alliances and other modes, has been substantively studied in INV research and in both qualitative and quantitative studies, and a clear connection between networks, networking activities and the development of INVs has been established (Oviatt and McDougall, 2005; Al-Laham and Souitaris, 2008; Gabrielsson et al., 2008). Some researchers have even argued for collaboration as a part of an underlying strategic orientation of the firm, as INVs seem to deliberately and proactively create, improve and orchestrate their network relationships to get access to the needed complementary resources (Mu and Di Benedetto, 2011).

Cooperation with other firms and with organizations is of particular interest for internationally fast-growth-oriented firms. These firms often have founders/entrepreneurs with earlier international competences; the products can be radically new, aiming for new markets and market segments with rapid and intensive development processes; and altogether such firms are driven by an underlying international orientation that places special demands on management, capabilities and resource mobilization (Blomqvist et al., 2008). At early stages of development, INVs are often dependent on one or a few products, and these are marketed on lead markets that could implicate distant markets, even on other continents (Mort and Weerawardena, 2006). In these processes there are obvious needs for such inexperienced firms with limited resources to build partnerships with other firms, both domestically and internationally.

Hence the past literature suggests that various forms of inter-organizational collaboration benefit the development of INVs and are consciously pursued by such firms as a core orientation. Furthermore, inter-organizational collaborations could also create unique firm-specific assets or resources for the INVs, facilitating their rapid internationalization. The above discussion leads to the following hypotheses regarding INVs’ national and international cooperation:
Continuing corporate growth of international new ventures in Sweden

H1: INVs are more likely to cooperate internationally than non-INVs.
H2: INVs are more likely to have a broader scope of international partnerships than non-INVs.
H3: INVs are more likely to cooperate nationally than non-INVs.
H4: INVs are more likely to have a broader scope of national partnerships than non-INVs.

2.2 Age of the INV

As an INV grows, research suggests that the firm proactively tries to address perceived gaps in its management teams by adding new members, who in turn bring their own knowledge-based resources in the form of relevant industry contacts, international networks or access to financial partners (e.g. Loane et al., 2007). It is also common for young entrepreneurial firms to change CEO at a rather early stage, sometimes by the initiative of their venture capital partners, who seek to add enhanced business knowledge, industry experience and networks (Hellmann and Puri, 2002). Thus, as new individuals are employed by or otherwise bringing their knowledge to the INV as it grows and matures, the scope of international partnerships can be expected to increase over time.

Multiple case-study research conducted by Coviello (2006) proposed that networks in the early stages of development of an INV are characterized more by business relationship and ties rather than by social ones. This could be attributed to the fact that INVs are often founded by individuals and groups with previous experience in business, thus making social ties less important as the early-stage INVs could then leverage the founder’s business networks. Coviello (2006) further argues that, as INVs experience early growth and internationalization, the network range will increase as well as the effective size, thus increasing the social capital of the INV.

Larson and Starr’s (1993) network model reflects a dynamic formation over time, involving relationships between both small and large organizations. Some researchers have found that factors developed even before the firm has started international venturing are influential, like prior experience and competence among founders, even if the main interest is linked to the role of networks after the start of internationalization activities in firms (Hoang and Antoncic, 2003). Coviello and Munro (1995), as well as Coviello (2006), found that INVs at very early stages of development are of a rather simple character, are socially oriented and form dyadic relations with external partners. They further argue that more growth-oriented stages need more professional network routines, including arm’s-length economic ties. This last aspect, that the content, density and complexity of network collaboration will increase with growth and professionalization
of firms, is common for the great majority of researchers in the field, even if the opposite view is advocated by, for example, Greve and Salaff (2003) as well as Hite and Hesterly (2001).

Organizational life cycles often suggest that firms undergo progressive stages of development, starting with emergency, early growth followed by later growth, maturity, and eventually also death (Hite and Hesterly, 2001; Al-Aali and Teece, 2013). In order to capture and analyze the first decade in the life span and development patterns for the INVs selected for this study, we chose to name firms in the emergency stage as ‘New INVs’, registered 2004–08, and firms at a stage of early growth as ‘Old INVs’, registered 1998–2003.

Thus we formulate the following hypotheses:

\[ H1a: \text{Old INVs are more likely to cooperate internationally than new INVs.} \]

\[ H2a: \text{Old INVs are more likely to have a broader scope of international partnerships than new INVs.} \]

### 2.3 Origin of an INV

Corporate venturing activities have become more frequent during the past couple of decades (Kuratko et al., 2009) and, while INVs stemming from a corporate venturing program arguably face fewer resource constraints than an independently started venture, they still face a high degree of uncertainty in the outcomes of their entrepreneurial activities, whether innovation (Phan et al., 2009) or internationalization (Zahra et al., 2000). Managers of the parent firm also, in a subjective measure of success in survey-based research, perceive corporate venturing in general as less successful than new product launches, due to the higher degree of uncertainty involved with starting an entirely new business (Kuratko et al., 2009).

Reasons why an established firm creates various types of spinoffs or new business ventures could be financial slack in the firm, learning or leveraging on specific organizational capabilities, or simply preventing entrepreneurial employees from leaving the firm and starting a new venture on their own (Phan et al., 2009; Kuratko et al., 2009). Further antecedents for corporate venturing could include implementation of a governance structure between the venture and the parent firm, where the spinoff has equity-owning management empowered to make entrepreneurial decisions, thus making the spinoff’s governance more like an independent new venture (Phan et al., 2009). In terms of performance, corporate INVs have been found to have a positive impact on the overall financial growth and profitability of their parent firms (Zahra et al., 2000).
New ventures formed by corporate parents could reduce their risk and improve their financial performance by leveraging on the resources, such as knowledge, legitimacy and networks, provided by their corporate parents or siblings (Phan et al., 2009; Kuratko et al., 2009; Callaway, 2008). As for corporate INVs in particular, the focal new venture could collaborate and share knowledge with similar subsidiaries in other countries, as well as the parent in the home country. International business research has also shown a multinational firm could gain advantages by diffusing its product and process innovations throughout its network, including its corporate INVs (Zahra et al., 2000).

Thus, given the availability and incentives for INVs created by corporate spinoffs or mergers to participate and access international networks, this category of firms can be expected to have a broader scope of international partnerships than conventional greenfield start-ups. INVs formed through mergers and acquisitions have not, to the authors’ knowledge, been looked at extensively in prior research, but calls to do so have been made (e.g. Callaway, 2008). As they can be assumed, just like spinoffs, to carry a distinct set of previous baggage in terms of resources and relationships into what legally would be considered a new venture, we find it valid to group the two together. The final set of hypotheses is thus:

\[ H1b: \ \text{INVs formed via mergers and spinoffs are more likely to cooperate internationally than new INVs.} \]

\[ H2b: \ \text{INVs formed via mergers and spinoffs are more likely to have a broader scope of international partnerships than new INVs.} \]

2.4 Controls

While the core focus of this study is on INVs’ networking aspects, we also include several control variables that have been shown in the literature to affect firms’ propensity to engage in collaborative arrangements for innovation. We do not develop explicit hypotheses, as the linkages are either well established or of limited interest. Below, we briefly explain the rationale behind including each control in the model.

Firm innovativeness

The current state of research on innovation acknowledges that innovative activity is inextricably linked to international activities and inter-organizational collaboration. Research on inter-organizational collaboration and innovation generally confirms that firms that cooperate and are involved in knowledge-sharing arrangements benefit from increased innovation capacity and performance as well (Pittaway et al., 2004). As
such, firm innovativeness is a strong explanatory factor behind involvement in cooperation.

**Firm size**
Small-firm advantages can be determined by their abilities to overcome barriers to growth via active cooperation in networks. For the purposes of improving innovation behavior, the mobilization of actors inside the firm as well as externally is found to be particularly successful in smaller firms. The limited scope of business activities and the size effect indicate that small firms are less R&D driven and more dependent on their capacity to capture and refine externally available knowledge and experiences (Muscio, 2007). The ability to utilize external knowledge is influenced by the level of basic competence within a company, the extent to which the company has earlier experience and so on; empirical research on this absorptive capacity is mainly conducted on larger organizations and R&D-intensive sectors.

Bougrain and Haudeville (2002) found that network cooperation allows small firms to decode and refine information flows necessary for successful innovation undertakings. Such flows resemble these feasible knowledge sources as ‘windows of opportunities’ found in development of technology, market penetration and organization structure. The authors also underlined that the informal basis for management and control in small firms is strongly linked to tacit knowledge embodied among significant actors. Damanpour and Wischnevsky (2006) agree that entrepreneurial organizations can have more informal structures, with loosely linked functions and flexible management systems; these characteristics can be prosperous for the development of radical innovation. Incremental innovation processes, on the other hand, are supported by more formalized and centralized organizational principles (Eisenhardt and Tabrizi, 1995; Almeida et al., 2003).

Even if research has indicated that larger firms have better opportunities to tap into the expertise of other large organizations through a stronger network structure and richer interface with external resource partners, we can also argue that both the motivation and the ability to learn can decrease with size. Levinthal and March (1993) found that large firms often rely on experiential learning processes for capacity building. Such processes will, however, guide the companies to dig in old terrain with focus of ongoing and established activities, while new fields of information and knowledge will be excluded. This ‘myopia of learning’ will negatively affect the innovation processes in larger firms. March (1991) saw the knowledge-building process as composed of sequential stages, starting with the ambition to explore a new business field in terms of
potential opportunities and ideas; later the process might unfold into activities to exploit the business concept with replication of established management routines. This means that larger firms are stronger in building and managing internal capabilities, while smaller firms are stronger in the process of exploiting new opportunities and more attuned to absorb external knowledge and experiences.

Thus firm size has to be accounted for when examining either national or international collaboration, particularly in the context of innovation.

**Enterprise group membership**

Being a member of a business group is likely to affect inter-organizational collaboration for innovation, as other members of the group may provide easily accessible complementary resources and capabilities for the focal firm. Furthermore, being a member of a business group may also increase the scope of collaboration, as other members of the group may provide the focal firm with new network contacts in other international markets, as well as different domestic contacts. As the group members are probably striving towards increased overall performance of the group, there may also be built-in incentives for facilitating collaborative activities within the business group.

**Dynamic capability**

The literature regarding dynamic capabilities could be seen as a fruitful starting point when discussing innovation and collaboration for innovation in both the general context and in the context of INVs competing in industries with a high level of dynamism. Dynamic capability could be defined in general as firms’ abilities to sense, shape and seize opportunities, manage threats and reconfigure the existing resource base. Teece (2007) also emphasizes the importance of business model innovation and reconfiguration for supporting the technological innovation within a firm, as technological innovation alone cannot build a viable business and commercial success without being accompanied by an astutely crafted business model. This is also supported by an in-depth case study by Dunford et al. (2010), which revealed that business models and their development may be connected to rapid internationalization by INVs.

Engaging in, sustaining and expanding relationships requires certain organizational skills and ability to realign the business approach. New business models, new managerial approaches/techniques and new ways of managing external relationships are all proxies for measuring a firm’s dynamic capabilities, as mentioned above. Firms with dynamic capabilities are thus likely to engage more heavily in inter-organizational collaboration. Thus firms’ ability to create new ways of doing business, new forms
and methods of external collaboration, and their reconfiguring of internal structures may be a strong explanatory factor behind any firm’s network scope.

3. EMPIRICAL APPROACH

The data for the study come from a longitudinal micro-level matched database that contains the following components: (1) background information on all Swedish firms for the years 1998–2009 that includes full accounting data, firms’ foundation year and how they were established; (2) information on all international transactions for the years 2000–2009; (3) results of the Swedish Community Innovation Survey (CIS) that was distributed in 2009 and covers the period 2006–08. CIS relies on a large sample of firms with ten or more employees, and examines firms’ innovation practices, including cooperation with different partners, and follows the principles and conceptualization outlined in the *Oslo Manual* (OECD, 2005). The summary report issued by Statistics Sweden (SCB, 2009) details the sampling procedure employed, as well as other aspects of the survey administration.

3.1 Identification of INVs

First, we needed to identify INVs using ‘time-to-internationalization’ and ‘international sales percentage’ as key variables for the years 2000–2009. This is to a large extent a judgment call. In past research, a wide range of operationalizations in regard to export ratio in relation to time elapsed since firm inception has been used to identify INVs. Metrics such as start of international sales within two years after inception (Knight and Cavusgil, 1996) or having 75 percent international sales within nine years after inception (Hashai and Almor, 2004) have been used.

The operationalization of INVs in a Swedish context was scrutinized by Halldin (2012), who concluded that a stringent definition of 25 percent export ratio after three years since inception could be used, along with a modest definition of 10 percent export ratio in five years. Gabrielson et al. (2008) argue that operationalization carries built-in flaws, as the metrics relevant for a certain firm are heavily influenced by the country of origin, the country’s neighbor markets and industry-specific factors.

However, given that more stringent as well as more modest operationalizations exist, we have chosen a ‘middle road’ by operationalizing INVs as having an export ratio of at least 10 percent within three years after
Continuing corporate growth of international new ventures in Sweden

Inception. Thus we capture firms that have started their international sales rapidly, but also those that have not yet done so, maybe for industry-specific reasons, yet have emerged strongly internationally in terms of export ratio. However, the fact that they have international sales early on implies an interest and orientation towards internationalization. In the second step, we identified which INV firms have taken part in the CIS, and ended up with 491 INVs.

3.2 Description of Variables

Dependent variables: international and national cooperation scope
Dependent variables are based on the CIS. In a matrix-type question, a firm indicates whether it has collaborated with any of eight possible partners: other firms within the business group; suppliers of equipment, material, components/software; customers or clients; competitors or other firms within the same industry; consultants, private labs; private R&D institutes; universities or colleges; and public R&D institutes. Furthermore, each partner can be located in five possible geographical areas: Sweden, Europe, the USA, China or India, and all other countries. Thus, National cooperation (within Sweden) is a variable that is the sum of \( i \in [0;8] \) partnerships: \( \sum_{i} r_i \). It ranges from 0 to 8 and is treated as a count outcome. International cooperation is a variable that is the sum of \( i \in [0;8] \) partnerships in \( j \in [0;4] \) geographical regions: \( \sum_{i,j} r_{ij} \). It ranges from 0 to 32 and also is treated as a count outcome.

Independent variables
The variables pertaining to the INV status of a firm are derived from the first step. Thus the variable INVorNot is a binary one showing whether a firm was born as an INV according to the rule of export sales of 10 percent or more within three years from inception; the value equals 1 if a firm is an INV. Age of INV is dummy-coded and shows when a firm was registered: before 2004 or after. The definitions of an INV refer to a particular export ratio specifically within five years from inception. Hence we use five-year intervals going back from the CIS year. Origin is also a dummy-coded variable that shows whether an INV was registered as a pure start-up or via some form of merger/spinoff. The choice is theory-driven, as we emphasize the contrast with ‘greenfield’ start-ups.

All other variables are based on the CIS. Three types of organizational innovations are possible: new business practices/models for organizing activities; new methods for organizing responsibilities and decision-making; and new methods for organizing external relationships with other firms or public institutions. Thus the variable dynamic capability
(DynCap) is defined as the sum of organizational innovations a firm has introduced and ranges from 0 to 3.

In terms of product innovativeness, a firm can introduce either a new good or a new service to the market. Three process innovations are possible: new or significantly improved methods of production; new or significantly improved methods of delivery; or new or significantly improved support activities for the firm’s processes. Thus ProdInn is a binary variable that has the value 1 if a firm has introduced product (either goods or services) innovation; ProcInn is also a binary variable with value 1 if a firm has introduced any process.

Business group membership (Group) is also a binary variable that shows whether a firm is a member of a business group or not. Finally, Size is measured according to number of employees in 2008.

Table 4.1 provides a summary description of the variables, their operationalization and frequency distributions. At the outset one can note that product, process and organizational innovations are rather infrequent phenomena. Furthermore, cooperation for innovation is even rarer. Such frequency of occurrence implies a large number of zero observations within the dependent variable and has implications for model specification, discussed in the next section.

3.3 Model Specification

Using zero-inflated negative binomial (ZINB) specification (Greene, 2008; Long, 1997), we model firms’ involvement in cooperative relations as follows.

First, we examine whether a firm cooperates at all – this is a binary yes/no decision, which can be explained by being an INV or a particular INV subgroup, firm innovativeness, dynamic capability and the background factors of size and business group membership. H1, H1a, H1b and H3 are tested at this stage. More formally, the probability of a firm having zero cooperation scope $y_i = 0$ given a set of values of explanatory factors $z_i$ follows a logit model: $Pr(y_i = 0|z_i) \sim \text{Logit}$. The parameters $\gamma$ of the model are interpreted in the same way as the parameters of a usual logit model. However, the outcome here is having a zero count. Thus negative values of $\gamma$ indicate a decrease in the probability of being in a group where the probability of zero count is 1. In other words, negative $\gamma$ coefficients indicate a positive effect of having at least one cooperative arrangement.

After coming to a group where positive counts are possible (i.e. a firm has at least one cooperative relation), we examine the scope of cooperation, that is, how many partnerships a firm has. In this study, we assume
Table 4.1 Description of the variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
<th>Value</th>
<th>%</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>INVorNot</td>
<td>1 if a firm is an INV (export sales of 10% or more within 3 years from inception), 0 otherwise</td>
<td>Not INV</td>
<td>89.38</td>
<td>4133</td>
</tr>
<tr>
<td></td>
<td></td>
<td>INV</td>
<td>10.62</td>
<td>491</td>
</tr>
<tr>
<td>Age of INV</td>
<td>Shows when an INV was registered: before 2004 or after</td>
<td>1998–2003 (Old)</td>
<td>60.69</td>
<td>298</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2004–08 (New)</td>
<td>39.31</td>
<td>193</td>
</tr>
<tr>
<td>Origin</td>
<td>Shows whether an INV is registered as a pure start-up or via some form of merger/spinoff</td>
<td>OriginMergSpin</td>
<td>87.37</td>
<td>429</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OriginNew</td>
<td>12.62</td>
<td>62</td>
</tr>
<tr>
<td>DynCap</td>
<td>Proxy for dynamic capability and is a sum of organizational innovations a firm has introduced. Ranges from 0 to 3. 0 if a firm did not introduce any organizational innovation</td>
<td>0</td>
<td>67.30</td>
<td>3112</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>12.22</td>
<td>565</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>11.79</td>
<td>545</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>8.69</td>
<td>402</td>
</tr>
<tr>
<td>National cooperation</td>
<td>Proxy for the scope of national cooperation (within Sweden) and is a sum of ( n_i ) partnerships: ( \sum r_{ij} ). Ranges from 0 to 8. Treated as a count outcome</td>
<td>0</td>
<td>78.03</td>
<td>3608</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2.92</td>
<td>135</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>4.09</td>
<td>189</td>
</tr>
<tr>
<td></td>
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<td>3</td>
<td>3.59</td>
<td>166</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>3.42</td>
<td>158</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5–8</td>
<td>7.90</td>
<td>368</td>
</tr>
<tr>
<td>International cooperation</td>
<td>Proxy for the scope of international cooperation and is a sum of ( i ) ( \subset {0, 8} ) partnerships in ( j ) ( \subset {0, 4} ) geographical regions: ( \sum_{i,j} n_{ij} r_{ij} ). Ranges from 0 to 32, maximum observed value is 28. Treated as a count outcome</td>
<td>0</td>
<td>83.02</td>
<td>3839</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>3.83</td>
<td>177</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>3.44</td>
<td>159</td>
</tr>
<tr>
<td></td>
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<td>2.53</td>
<td>117</td>
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<td></td>
<td>4</td>
<td>1.51</td>
<td>70</td>
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<td></td>
<td>5</td>
<td>1.38</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6–28</td>
<td>4.28</td>
<td>198</td>
</tr>
<tr>
<td>Size</td>
<td>Number of employees in 2008. Continuous variable, presented here in brackets for convenience</td>
<td>10–50</td>
<td>67.26</td>
<td>3110</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50–250</td>
<td>19.80</td>
<td>916</td>
</tr>
<tr>
<td></td>
<td></td>
<td>250–</td>
<td>12.93</td>
<td>598</td>
</tr>
</tbody>
</table>
that this decision is explained by the same set of factors as the first decision. H2, H2a, H2b and H4 are tested at this stage. More formally, the probability of a firm having the number of partnerships $y_i$ given a set of values of explanatory factors $x_i$ follows the negative binomial (NB) model: $Pr(y_i|x_i) \sim NB$. The parameters $\beta$ of the model are interpreted in the same way as the conventional NB regression model. Here, positive values indicate a positive effect on the probability of having more partnerships. Also, if variables that positively affect the expected count (cooperation scope), those with positive $\beta$, also positively affect the chances of being in a group where positive counts are possible, then $\beta$ and $\gamma$ will have opposite signs (Long, 1997).

4. RESULTS

Results of the effects of independent variables on international cooperation scope are reported in Table 4.2, which has two parts: the bottom one, under the ‘logit’ heading, reports the results of the logit model, which estimates the probability of having no international cooperation at all. The upper part, under ‘NB’, evaluates the effects of parameters on cooperation scope. Table 4.2 also reports three separate models: the first with just the binary INV variable; the second splits INVs into Old vs New, and the third compares pure start-ups with INVs formed via mergers/spinoffs. All models, as a whole, are statistically significant (LR chi$^2$(6) = 53.28;
Table 4.2  Zero-inflated negative binomial regression for international cooperation for innovation

<table>
<thead>
<tr>
<th></th>
<th>INV*</th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>β</td>
<td>s.e. a</td>
<td>z</td>
<td>p</td>
</tr>
<tr>
<td>Size</td>
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<td>0.00</td>
<td>3.50</td>
<td>0.00</td>
</tr>
<tr>
<td>Group</td>
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<td>-0.12</td>
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</tr>
<tr>
<td>ProcInn</td>
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<td>0.10</td>
<td>0.04</td>
<td>0.97</td>
</tr>
<tr>
<td>ProdInn</td>
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<td>0.13</td>
<td>3.10</td>
<td>0.00</td>
</tr>
<tr>
<td>DynCap</td>
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<td>0.04</td>
<td>3.14</td>
<td>0.00</td>
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<td>INVorNot</td>
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<td>0.11</td>
<td>1.77</td>
<td>0.08</td>
</tr>
<tr>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>OldINV</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>OriginNew</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>OriginMergSpin</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>_cons</td>
<td>0.54</td>
<td>0.17</td>
<td>3.20</td>
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</table>

Logit

<table>
<thead>
<tr>
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<th>γ</th>
<th>s.e. a</th>
<th>z</th>
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<tbody>
<tr>
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</tr>
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<td>INVorNot</td>
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<td>-2.59</td>
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</table>
Table 4.2 (continued)

<table>
<thead>
<tr>
<th>Logit</th>
<th>( \gamma )</th>
<th>s.e.</th>
<th>( z )</th>
<th>( p )</th>
<th>( \gamma )</th>
<th>s.e.</th>
<th>( z )</th>
<th>( p )</th>
<th>( \gamma )</th>
<th>s.e.</th>
<th>( z )</th>
<th>( p )</th>
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<tbody>
<tr>
<td>NewINV</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.48</td>
<td>0.29</td>
<td>-1.62</td>
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<td>-</td>
<td>-</td>
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<td>OldINV</td>
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<td>-</td>
<td>-</td>
<td>-0.50</td>
<td>0.23</td>
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<td>0.03</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>OriginNew</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>0.52</td>
<td>0.52</td>
<td>0.98</td>
<td>0.33</td>
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<tr>
<td>OriginMergSpin</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>22.49</td>
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<td>0.17</td>
<td>22.59</td>
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<td>/lnalpha</td>
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<td>0.14</td>
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<td>0.10</td>
<td>0.14</td>
<td>0.70</td>
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</tr>
<tr>
<td>Alpha</td>
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<td>0.16</td>
<td>1.12</td>
<td>0.16</td>
<td>1.12</td>
<td>0.16</td>
<td>1.10</td>
<td>0.15</td>
<td></td>
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</tr>
</tbody>
</table>

Notes:
- \( N = 4624 \), \( N \) of non-zero observations = 785; \( \beta \) and \( \gamma \) are unstandardized coefficients; \( z \) is a \( z \)-test of \( \beta \) and \( \gamma \). * Overall model results are reported for INV model, the other two are nearly identical: log likelihood = -3284; LR chi(6) = 53.28; \( p = 0.00 \); Vuong test of zero-inflated vs standard negative binomial: \( z = 10.69 \), \( p = 0.00 \).
- Robust s.e.
Continuing corporate growth of international new ventures in Sweden

105

and thus are a significant improvement on models with no predictors. Furthermore, the high positive values of the Vuong test (Vuong, 1989) confirm that the zero-inflated model is preferred to the standard NB model \((z = 10.69, p = 0.00)\). Finally, the overdispersion coefficient alpha is highly significant (LR test for alpha = 0, chibar2(01) = 821.26, \(p = 0.00\)), suggesting that ZINB specification is preferred to Poisson.

To begin with H1, the results suggest that being an INV has a positive effect on the probability of having at least one international partnership \((\gamma = -0.49, p = 0.01)\). Thus H1 is confirmed – INVs are more likely to cooperate internationally than non-INVs. This is a net effect that cannot be attributed to factors captured by other variables.

INVs are also more likely to have more international partnerships \((\beta = 0.20, p = 0.08)\), an effect that confirms H2, which suggests that INVs are more likely to have a broader scope of international partnerships than non-INVs. Overall, this is a situation where being an INV positively affects both the expected count, cooperation scope in this case, and the chances of being in a group where positive counts are possible.

The effects of the other variables show more diverse effects. All the independent variables except \(Size\) have a positive effect on the probability of being in positive count group, that is, having some international partners. Note that the coefficient and standard error of \(Size\) is so small that it is rounded to 0.00. However, the pattern changes when it comes to the effects of the variables on the number of international partnerships. Here, \(ProcInn\) and \(Group\) are not significant. Thus, while being innovative in terms of processes and belonging to a business group helps inclusion in the positive-count group, these variables have no effect on the expected scope of cooperation.

The effects of INVs’ age are reported in Table 4.2 under ‘Old vs New INVs’. The model is identical to the first one, the only difference being that the INVs from model one are now split in two groups, those started in 2004 or after (\(NewINV\)) and before (\(OldINV\)). In this case, \(OldINV\) has a positive effect on being in a group where positive counts are possible \((\gamma = -0.50, p = 0.03)\), while the effect of \(NewINV\) is not significant. Hence H1a, which suggests that \(OldINVs\) are more likely to cooperate internationally than new INVs, is supported. Interestingly enough, the effects are reversed when it comes to the effect on scope of international cooperation. Here, it is \(NewINV\) that has a positive effect on the expected count of international partnerships \((\beta = 0.34, p = 0.06)\) and, thus, yield no evidence to uphold H2a.

The effects of an INV’s origin, that is, whether it was established as a pure start-up or via some form of merger/spinoff, are examined in the last part of Table 4.2 under ‘Spinoff/merger vs pure start-up INVs’. It appears
Innovation and entrepreneurship in the global economy

that being a pure start-up, OriginNew, is not related to either probability of being in the group where international cooperation is possible or to the scope of such cooperation. However, these results should be treated with caution as the number of pure start-up INVs in the sample is very small \((N = 62)\). Firms that started via mergers or spinoffs, on the other hand, are both likely to be in the positive-count group and have a higher level of cooperation scope \((\gamma = -0.62, p = 0.00; \beta = 0.20, p = 0.09)\). Hence both H1b and H2b are supported.

Finally, the test of hypotheses H3 and H4, which refer to the involvement and scope of national cooperation, is reported in Table 4.3. The layout of the table is identical to that of Table 4.2, the only difference being that we examine only the effects of being an INV or not, without examining the effects of age or origin. Both \(\gamma\) and \(\beta\) coefficients are not significant \((\gamma = 0.04, p = 0.75; \beta = 0.01, p = 0.85)\), prompting the conclusion that being an INV has no effect of the probability of being involved in national

Table 4.3  Zero-inflated NBR for cooperation for innovation within Sweden

<table>
<thead>
<tr>
<th>NB*</th>
<th>(\beta)</th>
<th>s.e. (^a)</th>
<th>(z)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
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<tr>
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<td>0.02</td>
</tr>
<tr>
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</tr>
<tr>
<td>INVorNot</td>
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<td><strong>0.05</strong></td>
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</table>

<table>
<thead>
<tr>
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<th>(\gamma)</th>
<th>s.e.</th>
<th>(z)</th>
<th>(p)</th>
</tr>
</thead>
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<tr>
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<td><strong>0.75</strong></td>
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<tr>
<td>Alpha</td>
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<td>0.02</td>
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</tbody>
</table>

Notes:
\(N = 4624\), \(N\) of non-zero observations = 1016; \(^*\) \(\beta\) and \(\gamma\) are unstandardized coefficients; \(z\) is a \(z\)-test of \(\beta\) and \(\gamma\). Overall log likelihood = -2264; LR chi^2(6) = 76.82; \(p = 0.00\); Vuong test of zero-inflated vs standard negative binomial: \(z = 16.69, p = 0.00\).

\(^a\) Robust s.e.
partnerships or the number (count) of different partnerships. Hence H3 and H4 are not supported.

4.1 Robustness Checks and Further Analysis

We subject our model to a range of tests to examine the stability of the results. First, we respecified the model as zero-inflated Poisson (ZIP) regression. Overall, the estimates from ZIP and ZINB are generally similar, although ZIP returned somewhat larger and more significant coefficients. The direction of the effects did not change. We also used alternative specifications of both independent variables and dependent variables: using DynCap as binary variable, restricting top count for international cooperation at various thresholds, using log-transformed values of Size, excluding cooperation with firms within own enterprise group from cooperation count, and examining robust standard errors (which we report in tables). Overall, the results are stable, as the direction and significance of the effects do not change.

We further proceeded to address the potential ‘excess zeros’ and endogeneity problems. Given the very nature of INVs, their status and innovativeness may be determined simultaneously, causing the reported estimates to suffer from endogeneity. Thus we reduced the dataset to include only innovative firms (ProdInn = 1, N = 1732). Doing so also alleviates the potential ‘excess zero’ problem, where firms report no innovation cooperation due to its irrelevance for reasons other than conceptualized in this study. Again, the results remain stable, as the direction and significance of the effects do not change. We further re-estimated models two and three (‘Old vs New INVs’ and ‘Spinoff/merger vs pure start-up INVs’) within the INV group only (N = 491), a procedure that yielded conclusions similar to those reported earlier.

A particular subset of robustness checks deserves further examination and is reported in Table 4.4. Here, we examine patterns of international cooperation of only small and medium-sized enterprises (SMEs), defined as firms with 250 employees or less; otherwise the table is identical to Table 4.2. A few aspects are of interest here.

First, the overdispersion alpha is similarly early significant, favoring the ZINB model. Overall significance of the model is also lower (LR chi²(6) = 11.23; p = 0.08), suggesting that the predictors we use do not fully capture SMEs’ international cooperation involvement. Examination of the γ and β coefficients suggests that the H1 and H2 groups of hypotheses return results similar to those already discussed. Being an INV positively affects both the probability of having international cooperation and its scope. In an SME context, both old and new INVs have a higher
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<th>NB</th>
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<th>Spinoff/merger vs pure start-up INVs</th>
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<th>( z )</th>
<th>( p )</th>
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<th>( z )</th>
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Notes:
N = 4026, N of non-zero observations = 521; *β and γ are unstandardized coefficients; z is a z-test of β and γ. Overall model results are reported for INV model, the other two are nearly identical: log likelihood = −2264; LR chi²(6) = 11.23; p = 0.08; Vuong test of zero-inflated vs standard negative binomial: z = 8.22, p = 0.00.

a Robust s.
probability of cooperating, a result different from that of the total sample. In line with the earlier results, new INVs tend to have a broader network, although the effect is only marginally significant ($\beta = 0.39, p = 0.10$). As before, INVs formed via mergers and spinoffs are more likely to be involved in cooperation, but the origin has no effect on the scope of cooperation at any conventional level of significance ($\beta = 0.25, p = 0.12$). With the exception of those differences, the results in the SME subsample are in line with those reported earlier.

5. DISCUSSION AND CONCLUSIONS

The purpose of this study was to examine the scope and pattern of inter-organizational collaboration of international new ventures (INVs) of different age, size and organizational form. To that end, we identified 491 INVs that participated in the fourth nationwide CIS in Sweden.

By modeling firms’ involvement in cooperative arrangements as a two-step process, we show that INVs are more likely to have some form of international cooperation than other firms, and that they are also more likely to have a broader scope of international partnership, in terms of both number of partners and geographic location of those partners. This is a net effect of being an INV that cannot be attributed to innovativeness, dynamic capability, firm size or belonging to the enterprise group. Many such young and fast-growing firms have a strong fundamental international orientation, based on their engagement in high-tech, knowledge-intensive, fashion- or design-driven sectors, but also with influences from entrepreneurial teams with international perspectives (Mu and Di Benedetto, 2011). So, the incitement among such INVs is strong to exploit first-mover advantage by proactively entering new markets (D’Angelo et al., 2013). In line with what was stated in H1, the combined competence and experiences within the network will guide the individual firm in the process to identify business opportunities, and design entry strategies on new foreign markets (Pittaway et al., 2004).

Our findings, that INVs are more often involved in international collaboration and that this group of firms likewise also has a broader international scope than others, were supported. This is in line with Knight and Cavusgil’s (2004) argument that INVs first-stage exploratory partnerships can subsequently launch further international networks and directly enhance commercial opportunities on foreign markets. Chetty and Stangl (2010) reported similar results when they compared INVs with innovation processes aiming to develop radically new products while simultaneously striving to rapidly internationalize. The scope of the international opera-
Continuing corporate growth of international new ventures in Sweden

111

The results also suggest that firms that were formed as a spinoff or as a merger of two or more firms have a broader scope of international partnerships and are more likely to enter one, compared with greenfield INV establishments. This could, in line with theory (Kuratko et al., 2009), be attributed to a higher degree of slack resources and relationship ties indicating that new spin-out companies may have the opportunity to tap into resources and competencies available via the parent organization (Phan et al., 2009).

Based on this, we believe that this study offers several interesting implications for management of INVs as well as for policy makers. First, our study suggests that early-stage INVs utilize a broad set of partners for facilitating their internationalization and market entries. Thus it becomes vital for the founders and/or management team of a potential INV to get access to these broad types of networks and broaden their perspective to include business activities on international markets.

Second, as this study shows, international cooperation becomes even more important for INVs reaching a stage of early growth, with the difference here being that the relevant partnerships have become more established and less scattered. Hence the crucial task for the INV management team going from the emerging to the early-growth stage is to filter out the most relevant partners and, with such significant partners, consolidate and professionalize the role of the network.

We would also argue that the results from this study and the managerial
implications discussed above may be a relevant basis for further development of policy and support programs. Companies established in small developed countries with limited domestic markets often develop strong international commitments at early stages (Spence and Crick, 2006). This is also the case for smaller and medium-sized firms in such countries, and in the case of fast-growing internationally oriented firms (INVs) the incitements and challenges to continuously enter and actively participate in international business and firm collaboration is strong. In such countries the policy sector, in the guise of public, semi-public or private actors, has over time had the role, via, for example, support programs and specific agencies, to stimulate the domestic business community to develop their international business competence. The results from this study indicate that appropriate support measures designed to positively influence INVs may be early-stage scanning programs where agencies can actively match the contact and collaboration needs of domestic INV firms with available nodes on a target market, and also assist INVs with concrete matchmaking measures. At later early-growth stages the INVs would benefit from competence and training programs to build network capabilities and develop advanced international business models (Autio et al., 2000).

Our study is survey-based and cross-sectional in nature, and suffers from many of the limitations of such an approach. While we checked for endogeneity concerns, they may persist. Our study also does not consider industry heterogeneity and the specifics of particular types of collaboration. Future work may gainfully focus on what types of partners are particularly relevant both in the international and national context. Examination of the outcomes of these innovation collaborations of INVs is a fruitful venue. For instance, Nummela et al. (2004) states that business models for this type of firms are generally co-created with other actors. Hence, how is the business model generation of INVs influenced by its innovation collaborations? Furthermore, business models and dynamic capabilities of INVs were used as control variables in this study. Additional research with a similar dataset could determine which dynamic capability aspects or business model facets are unique to INVs.

ACKNOWLEDGMENT

Support of Maud och Samme Lindmarks Familjestiftelse is gratefully acknowledged.
NOTES

1. A business group is an association of firms bound together by legal and/or financial links (OECD, 2005). The CIS clearly instructs a respondent that the answers should pertain to the individual firm and not to the whole business group.
2. We would like to thank two anonymous reviewers for raising these points.

REFERENCES


5. **Routines: do they stimulate or hinder learning and innovation in industrial production?**

**Knut Ingar Westeren**

1. **INTRODUCTION**

The routines concept has been discussed starting from various traditions. Scientific contributions link routines to an organization like a company or a public sector unit and in general talk about organization routines; in this chapter we will keep our focus mainly on the company level. From one point of view, routines are linked to the concept of technology and the interaction of manpower and capital, with a large variety of examples, from fish farming to steel structure production to service production from consultant firms. On the other hand, routines are operational within organizations and here the focus normally is on the organization’s capability to establish, develop and change the routines. When we look at the literature, we normally do not find that one tradition denies the other, but Nelson’s (2009, p. 11) view on this is illuminating:

> In any case, it is clear that the theory about routines and their evolution . . . has in fact spawned two quite separate intellectual communities. One concerned organizational capabilities and behavior, where focus is on ‘social’ technologies. The other is concerned with the evolution of ‘physical’ technologies. It is also evident that these two different communities look at the role of understanding in the evolution of routines in different ways.

Many articles and studies emphasize an integrative view (see Becker, 2004 for examples). When we look at the developments in the last decade (see Pentland et al., 2012), it looks as if the integrative view dominates, where the focus is on understanding how social and technological factors work together within the organization. This is also the view taken in this chapter and applied in the empirical example.

Routines now take place in a large variety of situations, and the knowledge content varies a great deal, as do the possibilities from learning from
Innovation and entrepreneurship in the global economy

routines, and their impact on innovations. But the main reasoning behind the concept of a routine is still to optimize organizational structure and productivity so that the organization finds the best solution to reach its goals.

The lesson from Schumpeter and evolutionary economics is still that routines normally increase an organization’s efficiency but reduce its adaptability to changing circumstances. One new development in the analysis of routines shows that the content of knowledge both to construct and manage routines has increased considerably. Another development is that the technology to manage and develop routines has also changed radically due to the use of information and communication technologies (ICT). One striking example is how routines for inventory management have changed profoundly as a result of the reduction in transport cost relative to the cost of the product and the ICT systems to manage transport.

Routines as a phenomenon have been defined in many ways, but the word commonly used is ‘pattern’, which is linked to rules/guidelines of behavior. In the literature at least three starting points emerge when we go further into the analysis (Becker and Zirpoli, 2008, p. 130):

1. Recurrent interaction patterns
2. Standard operating procedures
3. Dispositions – stores behavioral capacities or capabilities.

The most common interpretation is that routines are understood as activity patterns that regulate behavior. When we look at the literature after Nelson and Winter (1982) we see routines normally interpreted in a collective way linked to group behavior.

This chapter first provides a theoretical discussion about the development of the concept of a routine. Then we look at an empirical analysis based on a data collection where we study a Norwegian company producing steel structures for the offshore sector. In the data collection we followed the company for 18 months and first analyzed how routines are created, maintained and changed so as to be labeled innovations. In the production of steel structures, one important routine is measuring accuracy. This is done with standardized procedures but there are possibilities for changes. As described in many articles in the literature, it is very important to stick to the routine because of quality control and productivity arguments. On the other hand, sometimes routines become more costly than necessary due to changes in technology and organization. In the empirical part we analyze the factors explaining changes in routines and when these changes fulfill the criteria of being an innovation.
2. THEORETICAL DISCUSSIONS OF THE CONCEPT OF ROUTINES

The concept of a routine has been in the subject of the economics, business and organizational literature for many years. It was introduced from an organizational perspective by Simon (1947) and later by March and Simon (1958, p. 142), not using the word ‘routines’ but speaking about ‘performance programs in organizations’. Later, Cyert and March (1963, p. 101) used the expression ‘standard operating procedures’. These sources are examined as early notions of the concept of routines and important contributions, but from today’s perspective they lack clarity as definitions.

Routines have been seen as one means to explain differences in behavior and performance between firms, and in their relative competitive advantages. The discussion of the concept of routines has also been compared to other fields of science, such as epistemology, so that it is interesting to analyze how different types of knowledge appear as a part of a routine. Routines as a focus of analysis from a more ‘technology and knowledge’ point of view were reintroduced by Nelson and Winter (1982), Teece et al. (1997), Winter (2000), Dosi et al. (2000) and others who were seeking to understand how the linkages between routines and knowledge could be established. There is no consensus on how to define and understand the concept of routines; an article by Becker (2004) discusses how different points of view on the subject have been elaborated over time.

There seems to be reasonable agreement that routines must have the characteristic of regularity. Looking at routines as standard operating procedures also focused on recurring patterns, but not normally on any specification of a causal mechanism. This view dates back to Cyert and March (1963) and, according to them, standard operating procedures are configured as decision rules.

It is interesting to analyze the origins of routines in an organization from a skills/knowledge point of departure. First, we look at the subject from the individual point of view, and here we can say that the researchers build mostly on the skills point of view from Nelson and Winter (1982). The main point here is that routines come from the skills and habits of individuals that correspond to the ability to act in a coordinated and sequential way, leading to the goal of the organization. Here it is important to underline that the knowledge embodied in skills is, as Polanyi (1962) says, linked to a particular context. In companies such as the one in the empirical example, we have routines on different levels, for example routines of an engineering department and routines of an operator (e.g. welder) in production.

To perform an activity as part of a routine that requires skills, workers
Innovation and entrepreneurship in the global economy

need more than just a plan to execute the task. They need to know the
different steps or parts of the routine and how the routine leads to the
desired result. Both Polanyi (1962) and Nelson and Winter (1982) take
the view that an activity carried out on the basis of skills is achieved due
to observation of a sequence of rules and standards already known. On
the individual level, skills can be developed, forgotten and/or regained.
This implies that behavior is not present in a unique way, ranging from
flexible to adaptable, but is more or less changing due to different circum-
stances. These circumstances open the way for the emergence of costs that
arise from the investment required to acquire, renew or develop the skills
involved in changes of behavior when old skills are forgotten.

According to Simon (1997), organizations move to achieve goals. To
reach them, the organization constantly evaluates the environment and
makes changes in behavior to adapt to changes in the environment. This
is a trial and error process where the accumulated knowledge generated
forms the basis for the creation of routines. This process can be inten-
tional, which means that there is an explicit effort involved in coordinating
actions and expected results. But an automatic process can also be incorpo-
rated into the learning context of the execution of daily activities. Besides
goals, we often have another selection process of routines from habits and
skills. At the top of the hierarchy, authority plays an important role in
the design of routines and in explaining what is the desired behavior. The
structure and division of labor also functions as a parameter and contrib-
utes to the explanation of the origin of routines. The selection process of a
company is formed by internal forces such as profit maximization, quality
control, system of incentives and promotions, and organizational culture.
It is the context of the company that ensures consistency and cohesion of
the actions of individuals and the emergence of organizational routines. It
is these routines that make individuals act collectively, minimizing poten-
tial opportunistic behavior and conflicts of interest.

But then the question arises: how to get from understanding established
routines to seeing how they change? The starting point here is that the
organization (e.g. the company) is in a field of negotiations that should
be responding to new features – internal or external – that may emerge.
As Giddens (1984) argues, it is necessary to understand the institutional
context as a process; this also relates closely to the evolutionary view of
Nelson and Winter (1982). Routines can therefore be dynamic, depending
on the activities for which they are developed; see the empirical example at
the end of the chapter.

A final comment on the more definitional aspect of routines is that
they can be interpreted as activity patterns or as cognitive patterns (see
Cohen et al., 1996; Becker, 2004). In the empirical example we will analyze
observable routines taking place in a company as a part of a production process, meaning actual activity patterns. Cognition is a process taking place in people’s minds; cognitive routines can be rules and operating procedures. In the discussion about the concept of routines it is not always clear which focus is being applied. Also it is questionable whether cognition can be separated from action. Following Polanyi (1962), learning and skills are complementary processes, and in the empirical example we will see that the cognitive aspects also play a role when routines change.

3. CHARACTERISTICS OF ROUTINES

3.1 Routines Understood as Collective Actions

Dosi et al. (2000) argue that there is reasonable consensus in the literature that routines should be understood as a collective phenomenon; see the earlier discussion about definitions of the concept. One argument that supports this view is that individuals as workers in an organization have bounded rationality that prevents them from having a complete picture of the situation, and therefore the relationship between them becomes crucial. People engaged in production see that a reasonably agreed pattern for guiding behavior leads to the best production result; we have seen many examples of this from studies and articles: Zollo and Winter (2002), Becker (2001) and Lazaric and Mangolte (1998) argue that routines end up as collective behavior. Once routines have become collective and distributed throughout the organization, they involve a process of interaction, as demonstrated by Cohen and Bacdayan (1994).

In this process individuals exchange information and insights, leading to standards of behavior in the organization. A study by Feldman and Pentland (2003) shows that from one point of view individuals act, but at the same time they are embedded in a context created by the actions of the other participants. At the start their actions seem to have independence; normally the end result of the actions is that routines end up as a collective result. Organizations normally have a social nature that is important for the transmission of knowledge. This means that routines, although collective, may be the result of common understanding filtering down the hierarchy. Some studies show that there is room for individual action, but this must be according to established routines. Otherwise individual actions involve disrupting the status quo. This may be the result when particular sets of routines are eliminated, which we will see in the empirical example at the end of the chapter.
3.2 Routines are Repetitive

Repetition has been an important feature of routines since the renewed interest and increased focus on them by Nelson and Winter (1982). The stability of repetition is one of the fundamental features of routines. According to Costello (2000) and Kesting (2007), routines are characterized by the ability of the actors to repeat their actions in the same or a very similar way. According to Nelson and Winter (2002), routines are repeated for several reasons. In the context of production units, one important reason is that they save costs in the way they store and access different types of knowledge. The repetitive nature of routines also leads to conflict-saving behavior of participants in production. Cohen and Bacdayan (1994) argue that routines can develop quite an automatic character and therefore need no or very little reflection: the agents performing them do so with little explicit attention or consciousness (see also Pentland and Rueter, 1994; Dosi et al., 2000; Betsch et al., 1998). On the other hand, studies also show that this development of routines into behavior with little consciousness may add to efficiency and coordination, but is problematic for organizations that want to find responses to new situations. Routines are created, implemented and limited due to the cognitive capacity of the individuals performing them and to the organizational structure. This structure provides possibilities for change, which will be discussed in more detail when we talk about path dependency.

3.3 Stability of Routines

As shown by Nelson and Winter (2002), routines are persistent for various reasons. One important reason is that they allow the organization to save knowledge. Nelson and Winter (2002) also link the arguments about stability and costs because when first a company’s strategy is developed and the technology adopted, a cost-saving process is normally adopted based on reasonably stable routines. The routines can then be seen as investments in knowledge and can be termed ‘cognitive sunk cost’ (Langlois and Robertson, 1995). It is interesting that this argument may seem negative at a first glance – it promotes inflexibility, to be applied to different contexts and realities. As routines may be part of individuals’ behavior in quite an automatic and subconscious way, this can lead to development problems that bring about inflexibility of the organization sometimes called its ‘genetic code’.
3.4 Dynamics and Routines

Although in the literature we find a great deal of evidence that routines promote stability, there are also indications that they change for different reasons. In the traditional view this can happen in two ways: through a process of trial and error or as a search process put in place by the organization. Normally routines are also linked to the goals of the organization; in management theory and practice it is regarded as an important feature of effective management that changes in goals are reflected in changes in routines. Changes in routines are also brought about by the simple fact that people think, feel and care about each other and the organization. Responses by members of the organization are seen as providing potential for change; one important feature of the organization is then to what extent it has mechanisms for transferring participants’ points of view, knowledge and suggestions into changed routines that are more productive than the status quo. A study analyzing routines in hospital (Edmondson et al., 2001) concludes that routines must also be understood in a dynamic manner. The study shows the interesting result that routines with a large number of repetitions also have the ability to be changed and improved because the large number of participants in the organization can argue more forcefully that the routine was wrong or not productive. According to Feldman (2000), routines remain unchanged if they meet the expectations of the stakeholders. Therefore it is important to see how exchanges of knowledge between the actual producing participants of the organizations meet the views of the stakeholders and vice versa.

Another way of looking at how routines work is from the point of view of the level of the organization. For Nelson and Winter (1982) and Cyert and March (1963), routines that apply to the strategic level of the organization must be to a lesser degree automatic. Normally we find more automated and stable routines connected with the actual production processes, but here too it is important to look at how the interchange of knowledge between the different levels of the organization works. Another useful way of analyzing routines is to look at the time horizon within which they are assumed to work. Take, for example, a car manufacturer that has established productive routines for producing cars with a specific type of engine. But it foresees the need for combined electric/gasoline cars demanding new production routines. This shows that routines must at the same time be stable, to take care of quality control issues and enhanced productivity and at the same time open up for future developments where new knowledge will be central for how they are performed. This dual nature of routines has been reflected in discussion about them since the 1980s.
3.5 Routines and Context Dependency

Many writers about routines (e.g. Cohen et al., 1996; Teece et al., 1997) argue that they are embedded in the organization and their structure is therefore context specific. This is because routines respond to characteristics of the organization, and there are complementarities between the routines and the context surrounding them. The implication of this is that routines can only be directly transferred in a few situations, and when this is possible there are limited degrees of transfer without changes. One argument behind the context-specific behavior of routines is that the knowledge they embed is often tacit (see Cohen and Bacdayan, 1994 and the empirical example in this chapter). Reproduction of tacit knowledge depends on the communication and understanding of the specific situation in which the knowledge is generated and transferred. In line with this, Nelson and Winter (1982) argue that there are obstacles in the repetition of routines when tacit knowledge is involved, and that this may increase transfer costs.

Tacit knowledge is normally linked to the skills of the workers, and its definition takes its point of departure as a process taking place based on the skills and knowledge of the individuals and the situation, culture and structure of the organization (see Jones and Miller, 2007). When one tries to transplant routines from an existing organization into a new one somewhere else, the process of knowledge transfer is normally not linear and the development of skills is dependent on the context of the new organization. Accordingly, the transfer of routines for a new plant will not be an exact reproduction of the old, but will, as Nelson and Winter (1982) say, demand modifications compared to the original organization. As important factors defined in the context of organizations, authors often mention the history, social and cultural background of the participants, the knowledge and learning environments and the way personal relationships are established. Another important consideration is that routines take place in a context of bounded rationality and cannot therefore be completely specified.

3.6 Routines and Path Dependency

Most writers state that routines are path dependent (e.g. Cohen and Bacdayan, 1994; Egidi and Narduzzo, 1997), but how exactly should this concept be analyzed when routines do not have a common interpretation? They can be modified incrementally in response to changes over time. Thus they can be seen as a reflection of the context in which they appear but not as the active factor generating changes in development.
3.7 Other Characteristics

Several other examples extend the analysis of routines in new ways. One quite new approach is to look at routines and how they deal with ‘triggers’. Triggers relate to specific characteristics of the context and structure of the organization that begin the actual process of transforming uncoordinated actions into routines. Another interesting starting point is to look at the substitution between routines and contracts. Here routines act as governance mechanisms within organizations, directing actions and thereby reducing possibilities for individual behavior.

4. EMPIRICAL EXAMPLE

4.1 Project Background

Aker Verdal is a Norwegian company that produces equipment for the offshore oil sector. The North Sea has been its primary geographic market, but in recent years the company has produced equipment used in offshore applications in Canada and the Gulf of Mexico. Between 2000 and 2009, the company had a total annual production value of about 200 million USD and employed roughly 750 workers. The main output produced by Aker Verdal is steel jackets, a market that has experienced significant changes in demand, large fluctuations in volume and changes in design and engineering. It is a great challenge for the company to maintain continuity in production when activity is low and market fluctuations are the rule rather than the exception.

Aker Verdal built a steel jacket called Valhall between May 2008 and June 2009. The jacket weighed about 7000 tons, had a cost of roughly 100 million USD, and took about 500,000 work-hours to build. The report from the Valhall project (Westeren, 2010) discusses many aspects of the production process; here we focus on analysis and data collection, looking at how routines are established, maintained and changed.

One of the reasons for the company’s success has to do with fulfilling very stringent requirements in welding quality for offshore products in the oil sector. All welding and other capital equipment can be bought on the world market, and the company has no technology-related patents. The competitive advantage for a company like Aker Verdal lies in the use of new cost-saving solutions. This requires adjustments in the entire production line, from design/drawings to manufacturing and work management, and control/testing of the job. The company’s competitive advantage is therefore both the actual knowledge/technological solutions
and how the whole production system is organized. Here routines are essential – they secure quality control and guide individual behavior so that productivity is enhanced.

4.2 Short Résumé of Data Collection and Project Analysis

Data collection for this project was based on observation and registration of central steps of the manufacturing process. It followed closely the entire production process; the central concept in the manufacturing design of a steel jacket is referred to as the ‘work package’. The production of Valhall was divided into approximately 600 work packages; each work package had complete drawings of the ‘piece’ that was produced, a description of all work processes (including welding technology) and test procedures for the acceptance of the work package in its final form, and an estimate of the number of work hours required for the production process. Work packages differed in size and content, from small jobs with fewer than 100 work-hours to large-scale operations of more than 2000 work-hours. This means that the routines were built into the work package.

The central characteristic of data collection in the project was how knowledge and other variables were linked to other properties of each work package. This was done by using an indicator set. For every indicator we registered values by having one member of the research team spend one (in some periods, two) day(s) each week at the production site. Special attention was paid to situations where work-hours were saved or lost compared to the standard calculation for the specific work package. The most important function of how communication and knowledge transfer took place in the production of the work packages included the central position of group leaders.

The variables used in the project were divided into the following groups:

1. Background and structural variables:
   - Calculated number of work-hours for each work package
   - Actual number of work-hours for each work package
   - Size (Actual number of work-hours) of the work package – recoded
   - Changed number of calculated hours of work package during production process
   - Group size (Number of welders and other workers at work package)
   - Average age of workers at work package
   - Average employment years at the company
   - Number of non-Scandinavian-speaking workers.
2. Human knowledge capital variables:
   ● Level of competence
   ● Participation in on-the-job training
   ● Welding technology.
3. Structural knowledge capital variables:
   ● Automated welding
   ● Understanding of drawings – level of complexity
   ● Measurement of accuracy – level of complexity.
4. Relational knowledge capital variables:
   ● Participation with other firms.
5. Variables linked to outcome of production:
   ● Extra hours used on measuring accuracy
   ● Extra hours used on interpreting drawings
   ● Production errors – extra hours spent
   ● Cooperating with other firms – extra hours spent
   ● Possibilities for process technology improvements – hours saved
   ● Hours lost because of non-responsive behavior
   ● Hours lost because of problems with logistics
   ● External quality control – extra hours
   ● Internal quality control – extra hours
   ● Waiting because of damaged equipment
   ● Insufficient manpower
   ● Extra hours because of insufficient manpower.

4.3 Analysis of Variables ‘Measurement of accuracy – level of complexity’ and ‘Extra hours used on measuring accuracy’

One variable for which we collected data was ‘Measurement of accuracy – level of complexity’. In the production process there are very strict requirements when it comes to measurement of accuracy and the quality aspects of taking measurements. This implies that this is a routinized variable and the content of the routine lies in the description of how measurement is supposed to be done. This varies from one job package to another, depending on production methods and the work package’s design. For this variable we used a three-scale level with ‘Low’, ‘Average’ and ‘High’ requirements for level of complexity when measuring accuracy, which means that we grouped the routines used into three broad groups.

The ‘Low’ level is defined as requiring only simple communication about how measurement will take place, which means that it does not need to be more than one message. Furthermore, the measurement is made on ‘first attempt’, which means that only one way of doing the job needs to be considered.
‘Average’ degree of complexity means that those who carry out the measurement know how to do it, and have a normal communication with those who do the actual welding and production operations on the work package. This communication takes less than one hour. When it comes to measuring accuracy with a ‘High’ degree of complexity, this is regarded as technologically difficult and can only be done by people who have significant training and experience.

The interpretation of the routines concept in relation to this variable borrows from all three understandings mentioned earlier. Measurement of accuracy is fundamental to securing quality, so recurrent interaction patterns are necessary for all participants in the production process. The first implication is that the routines concept here is on a collective level – there is always group responsibility for the quality of production, and all members must have the same ‘technical’ understanding of how measurement will take place. The company describes in quality manuals how the measurement procedures should be done, but the interaction of the workers is essential for successful operations – which underlines the organizational and managerial aspect of the routine. Also, workers must have specific capabilities before starting each new job. One conclusion so far is that aspects from all three interpretations of the routines concept are important for an analysis of the subject.

We also defined the variable ‘Extra hours used on measuring accuracy’. The definition of extra hours is that the first attempt to measure failed or did not work the way the production plan anticipated. Extra hours are taken to mean the number of hours it took to do the job once more or several more times. This variable therefore indicates how many hours were spent when the routine did not function the way it was supposed to.

The actual measurement of the results from the variable ‘Extra hours used on measuring accuracy’ shows that this situation occurred in 53 work packages; see Figure 5.1. The structure of what we call the measurement problem is twofold, in the sense that we have 34 work packages in which from 2 to 5 hours extra are used for the measurement of accuracy, while the other work packages where this problem occurred is distributed mainly within the range of 8 to 20 hours. It turns out that there are a few work packages where the company really had a major problem with measurement. The total number of hours lost as extra hours spent on accuracy is 548 and the average time is just over 10 hours.

This variable can be interpreted as a problem in performing the routine. To perform a more detailed analysis of the measurement problem and the routines linked to it, we built a regression model for the variable ‘Extra hours used on accuracy’, and this model came out with a high overall explanatory effect: we found an adjusted $R^2$ of 0.823, meaning that the
Table 5.1  Measurement of accuracy – level of complexity for work packages

<table>
<thead>
<tr>
<th>Level of complexity</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>48</td>
<td>11.1</td>
</tr>
<tr>
<td>Average</td>
<td>194</td>
<td>45.0</td>
</tr>
<tr>
<td>High</td>
<td>168</td>
<td>39.0</td>
</tr>
<tr>
<td>Total valid answers</td>
<td>410</td>
<td>95.1</td>
</tr>
<tr>
<td>Not answered</td>
<td>21</td>
<td>4.9</td>
</tr>
<tr>
<td>Total</td>
<td>431</td>
<td>100.0</td>
</tr>
</tbody>
</table>


Figure 5.1  Distribution of responses for the variable ‘Extra hours used on measuring accuracy’
The first independent variable that is significant is ‘Work from others – hours spent’ and is defined by counting how many hours of work from outside contracting firms are bought in to produce the work packages. Measurement is only done by the company’s own employees, but some external firms are hired, for example, for welding jobs when the company has problems with time limits. The results show that the more external contracts work-hours are used, the more extra hours are spent on measuring accuracy. This shows that external firms do not have quality at the same level as the company’s own employees to perform the routines correctly. Aker does not hire external firms to save money – it has much more to lose from low quality than it could save on hiring from low-cost firms. This result also shows that Aker has little or nothing to learn from outside welding firms; in-firm quality developments are more productive.

Table 5.2  Regression results, dependent variable ‘Extra hours spent on measuring accuracy’

<table>
<thead>
<tr>
<th></th>
<th>Non-standardized coefficients</th>
<th>Standardized coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>−1.500</td>
<td>1.802</td>
<td>−0.833</td>
<td>0.406</td>
</tr>
<tr>
<td>Work from others – hours spent</td>
<td>0.445</td>
<td>0.021</td>
<td>0.702</td>
<td>21.459</td>
</tr>
<tr>
<td>Loss of hours, non-responsive behavior</td>
<td>0.052</td>
<td>0.008</td>
<td>0.200</td>
<td>6.705</td>
</tr>
<tr>
<td>External quality control – extra hours</td>
<td>1.182</td>
<td>0.196</td>
<td>0.185</td>
<td>6.022</td>
</tr>
<tr>
<td>Extra hours used on interpreting drawings</td>
<td>0.619</td>
<td>0.135</td>
<td>0.129</td>
<td>4.575</td>
</tr>
<tr>
<td>Measurement of accuracy – level of complexity</td>
<td>0.922</td>
<td>0.434</td>
<td>0.066</td>
<td>2.126</td>
</tr>
<tr>
<td>Number of non-Scandinavian-speaking workers</td>
<td>0.061</td>
<td>0.020</td>
<td>0.108</td>
<td>3.120</td>
</tr>
<tr>
<td>Level of competence</td>
<td>−0.494</td>
<td>0.413</td>
<td>−0.036</td>
<td>−1.197</td>
</tr>
<tr>
<td>Average employment years at the company</td>
<td>−0.108</td>
<td>0.092</td>
<td>−0.035</td>
<td>−1.169</td>
</tr>
<tr>
<td>R</td>
<td></td>
<td>R-square</td>
<td>Adjusted R-square</td>
<td>Std error of the estimate</td>
</tr>
<tr>
<td></td>
<td>0.910</td>
<td>0.829</td>
<td>0.823</td>
<td>3.765</td>
</tr>
</tbody>
</table>

independent variables explain 82.3 percent of all variation in the dependent variable; see Table 5.2.
Specialized welding is the most important core competence of the firm – and Aker tries to hire the same outside firms to avoid low quality. This strategy also shows that Aker is not afraid that outside firms will learn from them and use this knowledge to compete. This finding complies with Haeussler’s (2006) finding that companies that compete are also more open about knowledge. From the routines point of view this analysis shows that Aker must spend resources on teaching routines to external companies, and this process gives rise to more errors and misunderstandings than for the company to use its own resources.

The next two independent variables that must be looked at together are ‘Loss of hours, non-responsive behavior’ and ‘Level of competence’. The first variable is significant (at the 5 percent level with a good margin), while the second is not. The variable is measured by looking at how the group leader operates. All work packages have a calculated number of work-hours and the group leader’s job is to supervise and advise groups of employees how to carry out the job, doing the work package and following the routines in a correct way. For some work packages the group leader has to interfere and instruct more than allowed for by the standard calculation of the work package – for all such work packages the number of ‘extra (unplanned)’ work-hours is registered and included in the variable ‘Loss of hours, non-responsive behavior’. So the interpretation of the regression result is that there is a positive relation between the number of extra hours spent by the group leader and the extra hours spent on measuring accuracy. In short, this result tells that if there is a communication problem, there is also a measuring problem. This highlights the communication part of a routine and how this interacts with the repetitive structure.

The variable ‘Level of competence’ is not significant as an explanatory variable in respect of ‘Extra hours used on measuring accuracy’. One might expect that the higher the level of competence, the fewer extra hours used on measuring accuracy. Since the function of measuring accuracy is a work process that requires technological skills, one might expect that level of competence would be relevant. In Westeren (2010), more testing of regression models is done and one interesting result appears. If we formulate a model as in Table 5.2 but take out the variable ‘Loss of hours, non-responsive behavior’, then ‘Level of competence’ becomes significant. The interpretation is that the communication variable ‘wipes out’ the knowledge level variable. A further analysis of this is that knowledge level is an important requirement, but in a production situation the communication variable is more ‘important’ to maintain the productivity of routines.

It is not surprising that the variable ‘External quality control – extra hours’ is significant with a positive sign in the regression model. When
there are problems with measurement, it is logical that the external controller also spends some time looking at this. The system works so that the external quality controller tests every work package, and when there are some problems, quality testing is more extensive than usual.

In the production process a review of the drawings is normally the first task to be done as part of the routine, and thus comes before the measurement takes place. In the regression model the variable ‘Extra hours used on interpreting drawings’ contributes as an explanatory variable to the variable ‘Extra hours spent on measuring accuracy’. The logic behind this is that if there is a problem with measurement, one should normally look at and analyze the drawings once more. The variable ‘Extra hours used on interpreting drawings’ is a combined communication and technological variable; the analysis here shows that one variable is not independent of the other.

The analysis also shows that the two measurement variables are linked. The connection works so that the higher the level of complexity when measuring accuracy, the more extra hours spent. This is not surprising.

In the analysis we have defined a variable ‘Number of non-Scandinavian-speaking workers’. This variable is measured as the number of non-Scandinavian-speaking workers that take part in the group for each work package. In the regression model this variable is significant and comes out with a positive sign, meaning that the higher the number of non-Scandinavian-speaking workers, the higher the number of extra hours spent on measuring accuracy. Here we see how a cultural background variable has a significant effect on performance of routines. It is important to add that the company has very strict procedures for quality testing and checking of welding certificates for non-Scandinavian-speaking workers, just as it has for all workers. So the problem is a communication problem and not a skill problem. This communication problem can also be better understood because we have tacit knowledge as an important part of the transfer of knowledge. It is likely that tacit knowledge transfers more easily in more homogeneous language environments – which is also an element of interest in interpreting the results above.

Another variable that may have had an effect in the model is ‘Average employment years at the company’, but the analysis shows no significance. We might have expected that the more experienced the workers are, the fewer extra hours spent on measuring accuracy. We have done some testing with non-linear model specifications and the experience variable mentioned here. It looks as if there is a trend towards an optimal number of years working at the company. The youngest welders become more productive during their first years of employment. But after a larger number
of years, experience does not contribute to productivity; on the contrary, productivity is reduced when we add more years.

To sum up, it is interesting to interpret this result in the light of the theoretical discussions. The concept of routine in this study does not refer to a routine as a very repetitive rule as such. In the routines literature it is made clear that we have routines on different levels and in this project the fundamental aspect of routine formulation is the same, but the actual execution of the routine changes from work package to work package. Some of the elements within the routine do not change at all, for example how a specific welding operation is supposed to be done. The ‘total’ routine in this project is the final design of the work package. This design again consists of several subroutines, some very strict and some that change from work package to work package. For the company, the question about productivity, knowledge and routines is how to link the subroutines together so that knowledge is utilized, stored and developed in the most productive way – meaning here at the lowest possible unit cost.

4.4 Routines and Innovations

In this chapter we offer some brief comments on changes in routines and innovations; a more detailed exposition of this is found in Westeren (2012). In the project we defined two variables in data collection that reflect process innovation activities related to manufacturing of work packages.

The innovation variables are as follows:

- Had an idea about process innovations
- Process innovations – work-hours saved.

It is difficult to differentiate between what can be seen as an improvement in the production process and what can be labeled an innovation. As already stated, during the production process, drawings, instructions and production methods that define the routine are closely followed. But in some cases changes were initiated in connection with the planning and production of the work package. Examples of process innovations we found included:

- Where work operations were conducted in a different way than planned
- When new welding techniques were used
- When the steel constructions were rotated (during production) in a different way than described in the planning material.
To register a process innovation, it must meet the following requirements:

- The production process must be carried out in a different way than described in the planning material for the work package.
- This must also lead to a productivity increase—meaning that we could register the number of hours saved compared to what was originally calculated.

Westeren (2012) offers regression results showing how the innovation variables vary with other interesting variables. Here some results of special interest for the discussion of routines are reported.

The variable ‘Extra hours used on interpreting drawings’ was significant in the regression model, which could be interpreted to mean that the work packages examined were those where we frequently found innovation activity. The variable ‘Extra hours used on interpreting drawings’ was actually a problem variable from the company’s point of view, meaning that either the explanations from the engineering department were not good enough or that the group leader’s explanation/communication was not sufficient. In any case, the extra attention the work package received fueled unexpected innovative actions that contributed to changes in routines that fulfilled the criteria of being an innovation.

Also significant in the model was the variable ‘Share of non-Scandinavian-speaking workers’ with robust $t$-values and a negative sign on the coefficient. This implied that the larger the share of foreign-speaking employees, the smaller the chance that innovative activities would occur. This conclusion suggested that communication was a central element in changes of routines leading to innovations.

The variable ‘Process innovations – work-hours saved’ included information about how many hours the company actually saved because of the innovation that took place on the actual work package. Saved work-hours for all registrations came to 846 hours, and the average saving was about 30 hours for each work package.

The regression model with ‘Process innovations – work-hours saved’ as dependent variable also had size of the work package as a significant explanatory variable in the sense that the larger the work package, the greater the chance that a high number of hours would be saved because of process innovation. This can be interpreted to mean that the more complicated the routine, the greater the chance of a productive change in it, which is a reasonable result. Also, the variable ‘Level of competence’ had a positive coefficient in the innovation analysis, meaning that the higher the level of competence, the more hours were saved. This result suggested a connection between knowledge and competitiveness and change in a
routine. To sum up, the statement in the theoretical part of the chapter is that changes in routines are also brought about by the simple fact that people think, feel and care about each other and the organization is an important driver of changes in routines. Together with the theoretical argument that knowledge matters, we find an interesting relationship between theory and the empirical study.

5. CONCLUDING REMARKS – A NEED TO WIDEN THE SCOPE FOR THE ANALYSIS OF ROUTINES?

The main lesson from this chapter is that the study of routines will increase in significance and that we also must develop the understanding of the concept applied to the new dimensions that are gaining importance, such as:

- The knowledge economy
- Project-organized production and/or production undergoing large changes
- The service sector and its interplay with goods production
- The demand for innovative behavior.

Many other aspects could be mentioned, but it is interesting to see how scientific contributions in the field of routines now focus on dynamic behavior (see, e.g., Pentland et al., 2012). This chapter also follows up this trend because the company used in the empirical example develops its productivity in a business environment facing great changes. Learning and productivity developments are at the core of the inclusion of both traditional and advanced technology production into the knowledge economy (see Westeren, 2012). In this setting many business leaders say that it is important to stick to routines to ensure quality control and at the same time change them in a cost-reducing and innovative way.

Results from the empirical part of this chapter show that the cultural attitudes of the company on different levels are important in a broad sense. The question can be put as simply as this: can an experienced worker suggest performing work operations differently from the descriptions in the quality handbook and still be seen as a loyal worker? In the empirical study we also saw that some suggestions about change in routines did not add to productivity. They may add to an innovative process – but the innovation often comes first after several failed suggestions to change routines.
A general trend in the analysis of production systems is the development of the knowledge economy. What is meant by this is discussed in Westeren (2012); three key elements are often examined:

- Knowledge workers
- Research and development activities
- Innovative behavior.

These developments favor the greater importance of tacit knowledge and how the organization can facilitate the environment to stimulate the process of transferring tacit into explicit knowledge. By definition it is only explicit knowledge that can form part of the documentation of a routine (see Gourlay, 2006). Several studies on the link between knowledge and productivity look at the emerging importance of tacit knowledge. What the interplay of explicit and tacit knowledge means for the development of and change in routines has not been a focus of analysis so far, but needs to be examined.

Organizations develop and change; one characteristic is that more time-limited organizations like projects that aim for a time-limited goal. Examples here go from the movie industry to production of steel constructions to medicinal developments in the pharmaceutical industry. We see projects organized in different ways with regard to ownership structure. For example, a movie is now often organized as a time-limited business with an ownership structure separate from the movie company. The argument is then how the movie company can learn and transfer successful routines into a new organization.

Routines linked to production activities were in earlier times mainly linked to goods production. Now routines in service production in both the private and the public sector have entered the scene. Some of the most debated subjects relating to routines now take place in the health sector and in transportation – such as in airport security control. So from being a subject to a large extent inside the organizational and production system, routines have now entered international and politically influenced debate.

REFERENCES


6. Creativity spillover of entrepreneurship: evidence from European cities

David B. Audretsch and Maksim Belitski

1. INTRODUCTION

What are the drivers of economic development in cities? It is a complex question, so it is not surprising that scholars have answered it from the managerial prospective of a firm (Shalley et al., 2004, 2009; Fleming and Marx, 2006; Shin and Zhou, 2003), and the regional and urban prospective (Lucas, 1988; Rodríguez-Pose and Vilalta- Bufi, 2005; Acs and Armington, 2006; Audretsch and Keilbach, 2007; Marrocu and Paci, 2012; Stephens et al., 2013). Despite the large number of studies examining the general and the direct relationship between various drivers of regional development, the black box of regional development – human capital, the creative class and tolerance – has been only recently researched (Florida et al., 2008; 2011; Florida and Mellander, 2010; Boschma and Fritsch, 2009) and challenged (Lorenzen and Andersen, 2009; Stephens et al., 2013). Although the complex relationship among the human capital, consumer services, university, talent and technology has been established, the role of entrepreneur as a spillover of this complex mechanism for regional development has been largely neglected. This is because the most popular approach offered by Glaeser et al. (2001, 2010) is that human capital builds on itself. Places with an initial competitive advantage build on this advantage, along with the importance of human capital clustered in research institutes and universities as a key factor in this set of initial advantages, production and further distribution of human capital (Florida et al., 2008, 2011).

The historical evidence of entrepreneurship-led growth in cities is vast (Audretsch, 1995, 2003; Audretsch and Keilbach, 2007; Rodríguez-Pose and Crescenzi, 2008; Fritsch and Mueller, 2004, 2007; Fritsch and Storey, 2014), to name a few. The historical evidence of entrepreneurship as a spillover of key factors that shape and determine economic development, including human capital, the creative class, tolerance and amenities, is
Innovation and entrepreneurship in the global economy

A large number of recent studies on creativity and knowledge spillovers of entrepreneurship (Acs et al., 2009; Agarwal et al., 2010; Marrocu and Paci, 2012) have yet to produce a consensus on how entrepreneurship can spill over knowledge across various agglomeration economies and over time (Mueller et al., 2008).

Our modelling approach is designed to address a significant weakness of previous studies and add to the black-box story (Florida et al., 2008) of the effects of the creative class, along with human capital and diversity on regional economic development. Most of these studies use a single-equation regression framework to identify the direct effects of human capital and other factors on regional development.

But that does not establish that other variables do not matter. First, entrepreneurship must affect the distribution of human capital (Glaeser et al., 2010). Variables that have not performed well in previous studies (Florida, 2004; Florida et al., 2008) may exert influence by operating through different channels such as entrepreneurship. By using a system of factors rather than separate variables in our model structure, we aim to capture the complementarity effect of entrepreneurship, human capital and creative class on regional development. Furthermore, our model is based on a strong *a priori* theory (Lucas, 1988; Glaeser, 2004; Florida, 2002; Törnqvist, 2004, 2011) of the relationships between and among key variables of skills, creativity, educational attainment and agglomeration economies as they shape regional development.

This study contributes to the regional and entrepreneurship literature in four important ways. First, entrepreneurship spills over human capital for higher regional development (Acs et al., 2009). Second, entrepreneurship spillover moderates the relationship between the creative class in various sectors and regional development (Amabile, 1996; Lee et al., 2004; Boschma and Fritsch, 2009; Glaeser et al., 2010, 2014; Audretsch and Belitski, 2013). Building on the knowledge spillover theory of entrepreneurship, we state that entrepreneurship spills over on to both education and skills, also known as the main creativity source (Törnqvist, 2004; Florida et al., 2008), demonstrating that entrepreneurship is a key conduit for skills and education to economic development in cities.

2. THEORETICAL FRAMEWORK

Although a link between creative class and economic development is intuitive (Florida, 2002; Glaeser, 2004; Audretsch and Lehmann, 2005; Boschma and Fritsch, 2009), the more in-depth analysis demonstrated more complex interactions between them (Florida et al., 2008). Creativity,
unlike educational attainment known as human capital (Arrow, 1962; Glaeser et al., 2001; Acs et al., 2009), is distinct from traditional resources: it is not excludable and non-transferable. Creativity is embodied in individuals’ skills (Florida, 2002). The distinction between skills and educational attainment as the conventional measure of human capital is clear from the example of highly influential entrepreneurs, such as Bill Gates or Michael Dell, who for various reasons did not go to or finish college (Florida et al., 2008). These entrepreneurs and many others like them have added immense value to the regional and global economies through their skills and experience. Creativity, unlike educational attainment, cannot be easily copied or taught. Therefore the creativity of a person is distinct from his/her educational attainment and is more personalized and unique.

Why does the creative class need to be pushed for higher regional economic development? Most creative class workers are not familiar with the market, legal forms of organization structure, institutions or regulations, how to run a business or how to create a market for their ideas. For example, individuals employed in finance, banking and business activities are more likely to estimate returns from their creative ideas and develop ways to commercialize them. Other creative class members (e.g. artists, painters, writers, computer and software engineers, IT specialists) are not likely to have market-analytical skills and other market-related knowledge. This is because their skills may not necessarily be business skills (artists, poets, doctors); therefore their uncertainty is high. In fact, Florida (2012) posits that ‘certain occupations are more important than others when it comes to entrepreneurship’.

Since creativity and skills as human capital are embodied in a creative class, but the implementation of ideas is limited due to the factors discussed above (e.g. non-transferability, uniqueness, market uncertainty), creativity may affect economic performance indirectly (Audretsch and Keilbach, 2007; Acs et al., 2009; Lorenzen and Andersen, 2009). As in the black box of regional development (Florida et al., 2008), we see entrepreneurship as a spillover of skills embodied in individuals, and termed the ‘creativity spillover of entrepreneurship’. This model, when provided with empirical evidence, should clarify where (industries with a relatively higher density of creative class occupation), when (climate of tolerance, openness and diversity) and why (higher proportion of firm start-ups) creativity may foster regional economic development. It adds to what we already know about the knowledge spillover of entrepreneurship model (Audretsch and Keilbach, 2007; Acs et al., 2009). We postulate that newly established firms may tap into the creativity embedded in a city–industry mix. Higher concentration of creative classes in a city will drive regional economic development (Florida, 2002; Florida et al., 2008) indirectly via
entrepreneurial start-ups in a Schumpeterian-style (1911) relationship. We therefore hypothesize:

\[ H1: \text{Entrepreneurship moderates the relationship between industries with a high density of creative class jobs and regional economic development (creativity spillover of entrepreneurship effect).} \]

Along with talent and technology, tolerance appears to be a necessary component of Florida’s 3Ts (Florida, 2002). Tolerance and openness to foreigners – or what Florida (2002) calls specifically ‘low barriers to entry’ for individuals – is associated with geographic concentrations of talent and new ideas, higher rates of innovation and regional development (Florida et al., 2008). Jacobs (1969) argued that firm-based diversity is associated with economic growth, but also that diversity of individuals is important for innovation and growth. The more diverse and open to other cultures is the space, the easier it is for new ideas to come into this space with new people, so the lower the entry barriers for human capital will be as well. Various measures of tolerance have been offered; for example, such attitudes towards gays and lesbians are associated with positive global economic activity. Florida and Gates (2001) found a positive relationship between number of gay households and regional development. Rather than looking at the relationship concentrations of gays, the Gay Index and regional development (Clark, 2003), or the Gay Index and the Bohemian Index (Glaeser, 2004), we focus on the proportion of non-EU migrants bringing their new cultures and ideas to Europe and thereby making local residents more tolerant through acceptance and self-expression. The environment where the creative class lives and works, be it a group, a firm, a district or a city, should be perceived as non-threatening, tolerant, open to different ideas and cultures to ensure that skills are freely exchanged (Shalley et al., 2004, 2009).

This idea has been supported at regional level (Florida, 2002; Florida et al., 2008), where creative class individuals with embodied skills release their potential better when they feel comfortable and in an environment that is non-threatening and conducive to new ideas (Shalley et al., 2004). The tolerant and open regional environment, filled with diversity and openness to outsiders, was termed a ‘melting pot’ city (Florida et al., 2008; Boschma and Fritsch, 2009). As a creative and tolerant environment gives birth to diversity and new ideas, entrepreneurs in the Schumpeterian sense (1911) will thrive there and lead to economic growth (Glaeser et al., 2010). Entrepreneurship will moderate the relationship between the ‘melting pot’ environment and regional development by spilling over new ideas with an accelerating effect. We hypothesize:
H2: A combination of ‘melting pot’ environment with higher entrepreneurial activity is likely to have a positive impact on urban economic development.

3. METHODOLOGY

3.1 Data

We utilize European Urban Audit Surveys (UAS) on European cities (Eurostat, 2012). UAS provide a comprehensive set of socio-economic, business, environment, entrepreneurship, national composition and education indicators. In order to demonstrate the moderating effects of entrepreneurship on urban economic development as a conduit of creativity, we selected new firm start-ups registered in a city with a dynamic approach to entrepreneurship (Shane and Venkataraman, 2000; Audretsch, 2003; Glaeser et al., 2010, 2014). Our cross-sectional dataset included 187 cities in 15 European countries during 1999–2009 (see Table 6.1) aggregated by three quadrennial periods: 1999–2002, 2003–06 and 2007–09. Figure 6.1 suggests entrepreneurship distribution across cities. Due to missing values in the data, the best approach was to aggregate indicators and generate cross-sectional data, retaining as many cities as possible. The extraction process yielded a total of 12 indicators. The market potential indicator was not extracted directly from Eurostat, but was designed for a robustness check. Table 6.2 displays the selected indicators and provides summary statistics.

The structure of the dataset can be characterized as: 153 (81 per cent) cities in Western Europe and 33 (19 per cent) cities in Eastern Europe. Another factor that should be taken into account is the distribution of the original data within time periods: 81 of the city observations were available from 1999 to 2002, 172 from 2003 to 2006 and 139 from 2007 to 2009. Our sample includes cities with at least 50,000 residents.

Our study follows the Eurostat classification of a core city, also known as the local administrative unit (LAU), corresponding to the administrative boundaries of the city (European Commission, 2010). The advantage of using LAUs is an emphasis on knowledge spillovers that occur within a certain area (Peri, 2005; Acs and Armington, 2006; Audretsch and Lehmann, 2005), as well as managerial concerns and responsibility when designing policies for cities.

It is important to note that economic activity may bypass core-city boundaries. The ‘total population’ indicator gives the amount of people living within the city, but does not include surrounding communities.
Table 6.1 Cities included in the study

<table>
<thead>
<tr>
<th>City</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brussels</td>
<td>Belgium</td>
</tr>
<tr>
<td>Ruse, Plovdiv, Burgas, Pleven, Varna, Sofia, Vidin</td>
<td></td>
</tr>
<tr>
<td>Lefkosia</td>
<td>Cyprus</td>
</tr>
<tr>
<td>Frankfurt am Main, Trier, Augsburg, Potsdam, Bonn, Wiesbaden, Mainz, Freiburg im Breisgau, Koblenz, Magdeburg, Weimar, Frankfurt-Oder, Erfurt, Dresden, Monchengladbach, Rostock, Darmstadt, Dusseldorf, Moers, Halle an der Saale, Hannover, Karlsruhe, Bochum, Schwerin, Leipzig, Bielefeld, Berlin, Regensburg, Munich, Essen, Mulheim ad Ruhr, Koln, Kiel, Dortmund, Hamburg, Nurnberg, Stuttgart, Saarbrucken, Bremen</td>
<td>Germany</td>
</tr>
<tr>
<td>Tallinn, Tartu</td>
<td>Estonia</td>
</tr>
<tr>
<td>Cordoba, Las Palmas, Gijon, Zaragoza, Santiago de Compostela, Badajoz, Malaga, Santander, Hospitalet de Llobregat, Vitoria/Gasteiz, Valladolid, Toledo, Sevilla, Murcia, Vigo, Oviedo, Sta. Cruz de Tenerife, Pamplona/Iruna, Bilbao, Madrid, Barcelona, Valencia, Logrono, Alicante/Alacant</td>
<td>Spain</td>
</tr>
<tr>
<td>Kernel Helsinki, Helsinki, Tampere, Turku, Oulu</td>
<td>Finland</td>
</tr>
<tr>
<td>Lens – Lievin, Tours, Rouen, Amiens, Ajaccio, Nantes, Paris, Metz, Marseille, Nancy, Orleans, Dijon, Le Havre, Grenoble, Poitiers, Strasbourg, Saint-Etienne, Montpellier, Limoges, Caen, Besancon, Saint Denis, Aix-en-Provence, Toulouse, Bordeaux, Lyon, Lille, Reims, Clermont-Ferrand</td>
<td>France</td>
</tr>
<tr>
<td>Budapest Debrecen Gyor Kecksmet Miskolc, Nyiregyhaza Pecs Szeged Szekesfehervar</td>
<td>Hungary</td>
</tr>
<tr>
<td>Panevezys, Kaunas, Vilnius</td>
<td>Lithuania</td>
</tr>
<tr>
<td>Ancona, Catanzaro, Venezia, Genova, Taranto, Perugia, Aquila, Potenza, Catania, Caserta, Cagliari, Foggia, Sassari, Verona, Bari, Roma, Salerno, Firenze, Milano, Brescia, Trieste, Napoli, Modena, Trento, Palermo, Reggio di Calabria, Bologna, Torino, Padova, Campobasso, Cremona, Pescara</td>
<td>Italy</td>
</tr>
<tr>
<td>Riga, Liepaja</td>
<td>Latvia</td>
</tr>
<tr>
<td>Almere, Breda, Arnhem, Apeldoorn, Amsterdam, Eindhoven, Tilburg, s-Gravenhage, Groningen, Leeuwarden, Rotterdam, Enschede, Heerlen Nijmegen, Utrecht</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Goteborg, Linkoping, Malmo, Orebro, Stockholm, Umea, Jonkoping</td>
<td>Sweden</td>
</tr>
<tr>
<td>Maribor, Ljubljana</td>
<td>Slovenia</td>
</tr>
<tr>
<td>Kosice, Banska Bystrica, Nitra,Presov, Zilina, Trnava, Bratislava, Trencin</td>
<td>Slovakia</td>
</tr>
</tbody>
</table>

Source: Authors’ calculations based on Eurostat (2012).

Figure 6.1 Average proportion of new business registered, 1993–2009
Table 6.2  Summary statistics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition</th>
<th>Mean</th>
<th>Std dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>Gross domestic product in PPP prices, logarithm</td>
<td>9.91</td>
<td>0.49</td>
<td>8.41</td>
<td>11.10</td>
</tr>
<tr>
<td>Human Capital</td>
<td>Number of students in tertiary education (ISCED 5–6)³ per 1000 inhabitants</td>
<td>95.31</td>
<td>55.76</td>
<td>0.00</td>
<td>349.50</td>
</tr>
<tr>
<td>Melting Pot Index</td>
<td>Non-EEA nationals as a proportion of total population</td>
<td>4.48</td>
<td>3.55</td>
<td>0.21</td>
<td>16.22</td>
</tr>
<tr>
<td>Entrepreneurship</td>
<td>New businesses registered as proportion of existing companies</td>
<td>16.67</td>
<td>10.58</td>
<td>4.57</td>
<td>47.53</td>
</tr>
<tr>
<td>Culture</td>
<td>Proportion of employment in culture and entertainment industry</td>
<td>2.10</td>
<td>1.14</td>
<td>0.40</td>
<td>7.10</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Proportion employed in mining, manufacturing, energy and electric power industry</td>
<td>16.58</td>
<td>7.54</td>
<td>3.55</td>
<td>55.10</td>
</tr>
<tr>
<td>Retail</td>
<td>Proportion of employment in trade, hotels restaurants and other food industry</td>
<td>20.39</td>
<td>4.84</td>
<td>12.10</td>
<td>35.53</td>
</tr>
<tr>
<td>Finance</td>
<td>Proportion of employment in financial intermediation and business activities</td>
<td>18.29</td>
<td>7.18</td>
<td>4.40</td>
<td>40.37</td>
</tr>
<tr>
<td>Public</td>
<td>Proportion of employment in public administration, health and education industry</td>
<td>29.73</td>
<td>11.76</td>
<td>6.83</td>
<td>50.80</td>
</tr>
<tr>
<td>Communication</td>
<td>Proportion employed in transport and communication</td>
<td>7.52</td>
<td>2.91</td>
<td>2.50</td>
<td>21.00</td>
</tr>
<tr>
<td>ICT</td>
<td>Proportion of employed in manufacturing ICT products and content</td>
<td>1.21</td>
<td>1.69</td>
<td>0.00</td>
<td>9.40</td>
</tr>
<tr>
<td>Population</td>
<td>Total population in Urban Audit cities for the period 1999–2002, thousands</td>
<td>383.02</td>
<td>475.67</td>
<td>51.14</td>
<td>3458.7</td>
</tr>
<tr>
<td>Market potential</td>
<td>Ratio of local administrative unit population density (LAU) to larger urban zone population density, 1994–2009 averaged (Harris, 1954)</td>
<td>12.94</td>
<td>36.38</td>
<td>0.80</td>
<td>354.54</td>
</tr>
</tbody>
</table>

Note: Interaction variables that are the product of entrepreneurship and proportion of employment by sector are supressed here to safe space. Number of observations is 187. Number of observations for Harris-type market potential control is 109.

Source: Authors’ calculations based on Eurostat (2012).
outside the core city. Therefore a question may arise over whether the surrounding agglomeration zone potentially affects urban economic development within larger urban areas. In Section 3.2, a robustness test is implemented that considers the overlap of economic activity between the LAU and large urban zones (LUZ). Leveraging this effect goes back to the concept of market potential (Harris, 1954).

### 3.2 Variables and Controls

Following the existing literature on entrepreneurship (Audretsch, 1995; Audretsch and Keilbach, 2007; Glaeser, 2004; Glaeser et al., 2010, 2014), we operationalize entrepreneurship as a proportion of new business start-ups to existing companies registered in a city. Economic growth in a city is our dependent variable, and is measured as a logarithm of GDP per capita in purchasing power parity (PPP) prices, in euros (Eurostat, 2012). GDP per capita was used in the extant literature as an indicator of economic wealth and growth at both regional and country levels (e.g. Anselin, 2010; Glaeser et al., 2010; Acs et al., 2009). In this sense, GDP per capita as opposed to income (Florida et al., 2008), is more place dependent.

**Other variables**

With respect to the demand side, industries were included (Audretsch, 2003; Stephens et al., 2013). Accordingly, the proportion employed in manufacturing ICT products and the proportion employed in culture and entertainment are also known as ‘Bohemians’. ‘Melting Pot Index’, the percentage of the population that are non-EEA (European Economic Area) nationals, is used to capture a size of ‘creativity filter’ consistent with the ‘melting pot’ climate of diversity, tolerance and openness to new ideas (Florida, 2002; Lee et al., 2004). The ‘melting pot’ climate is responsible for diffusion of ideas by creating a comfort zone for creativity also characterized by psychological comfort, openness, tolerance and diversity. We use the number of students in tertiary education (ISCED 5–6) per 1000 inhabitants as a measurement of human capital, the proxy criticized by Florida et al. (2008).

Additionally, population size was included as a proxy for the economies of scope and scale (Glaeser, 2004; Acs and Armington, 2006; Rodriguez-Pose and Crescenzi, 2008; Boschma and Fritsch, 2009). Finally, we control for the presence of a country’s fixed effects, capturing first of all the impact of institutions, culture and other unobserved heterogeneity across countries by including country dummies (Baumol, 1993). An F-test, testing if all coefficients of country dummies are jointly equal to zero, was rejected at the 1 per cent significance level.
3.3 Methodology

There are three potential criticisms of our model: endogeneity, multicollinearity and non-linearities. The relationship between creative class and economic performance is bi-directional (Florida, 2002; Boschma and Fritsch, 2009; Falck et al., 2011). Successful and wealthy European cities have vibrant cultural environments with a distinctive ‘melting pot’, rich in cultural amenities and creative class. The endogeneity issue also arises with high-human-capital individuals’ ability and willingness to pay for cultural services, bridging the bi-directional relationship between human capital and creativity. Factors such as amenities, culture, social capital and quality of life may affect both education and skills. A consensus has also developed over the bi-directional relationship of human capital and regional economic development (Partridge and Rickman, 2003).

Although there is a substantial set of variables available (Eurostat, 2012) to test the hypotheses stated, a non-linear regression modelling should be applied. Many of the variables are strongly correlated with factors that are unobserved, that is, with residuals (e.g. ‘industry mix’, employment in sectors, human capital), which violates the Gauss–Markov OLS assumption of linear independence. Furthermore, a relationship between economic development and industries with a high concentration of creative class is non-linear as we cannot assume constant marginal returns to creativity (see Figures 6.2a–6.2c). We introduce two-stage analysis. In the first stage, we utilize principal component analysis (PCA) to identify common variances in the data and build a set of orthogonal indexes. For example, the variables of Bohemians and Population size are correlated and therefore form a common dimension ‘Bohemians – Agglomeration’. In the second stage, we use regression analysis, where a set of orthogonal indexes obtained at the first stage is used as explanatory variables in the economic development model.

Although the PCA approach has the disadvantage that indicators contained within factors cannot be disentangled, the factor loadings produced enable us to make sense of these factors, keeping all variables they explain within the same pillar – the orthogonal index. To alleviate this problem, the grouping of indicators has been carefully analysed. We start by drawing on a basic specification (specification 1) and then rerun factor analysis estimations using the option ‘rotate oblimin’, adding interaction terms one at a time. Many of the factor loadings are repetitive across seven specifications (e.g. ‘Bohemians – Agglomeration’, ‘Manufacturing – ICT’, ‘Human Capital’, ‘Melting Pot – Finance’). We also find factor loadings that are industry specific, such as ‘Education – ICT’, ‘Finance – Service’. All factor loadings are used as explanatory variables in eight models.
Note: (a) Culture; (b) finance and banking activities; (c) ICT. Estimation method: estimated weighted least squares linear fit (known as ‘lowess’ smoothing).

Source: Authors’ calculations based on Eurostat (2012).

Figure 6.2 Interaction effects between employment in culture, finance, ICT and regional development conditional on start-up rates in cities
Figure 6.2 (continued)

Product of new firm start-up and prop employment in ICT

GDP per capita in PPP, log

bandwidth = 0.8

120

60

0
The data on the amount of variance that is unique to the variable are not included in the identified factors to save space.

Cumulative variance shows the amount of variance explained by \( n + (n - 1) \) factors. In our case, factors one to five account for 76.7 per cent of the total variance in basic specifications. Specifications three (culture), four (manufacturing), five (finance) and seven (ICT) account for the higher total variance. This is evidence that the indirect impact of sectors with a higher concentration of creative class adds to the explanatory power of models. Factor structure in this study is stable, given that the observations-to-variables proportion of 187:12 (15.6:1) is well above the accepted 10:1 recommendation for PCA (Osborne and Costello, 2004). Having established a set of dimensions, we move to the second stage of econometric modelling.

We use the following seven specifications to predict economic development in European cities. The interaction analysis was done following Brambor et al.’s (2006) methodology. Our model is as follows:

\[
Y_i = \beta_1 X_i + c + e_i \tag{6.1}
\]

where \( i = 1, \ldots, 187 \) cities, \( Y_i \) is our dependent variable, the natural logarithm of GDP per capita in PPP. Each model includes five indices as explanatory strictly exogenous variables, X-vector matrix, country dummies (\( C_i \)), a constant (\( c \)) and an error term \( e \). Interaction is included in each equation as an interaction of new business-start-ups and an industrial sector (specified in columns).

We combine the feasible generalized least squares (GLS) and robust approaches in our cross-section/heteroscedasticity practice model. It is reasonable to do feasible GLS on a cross-section to get improvements in efficiency and then use robust standard errors to address remaining heteroscedasticity detected in the model clustered by country.

4. RESULTS

Our PCA (first-stage) finding is consistent with the big-city orientation of Florida’s theory. The higher correlations for larger metropolitan areas suggest that applying Florida’s theory to smaller cities may weaken the link between creativity and economic development. Furthermore, cities with a higher proportion of non-EEA residents are likely to be centres with a well-developed business intermediation and finance sector. Our second-stage analysis operationalizes entrepreneurship as a spillover of creativity. More technically, we interacted new business start-up rates in
cities with the proportion of workers in each sector by NACE. We are interested in sectors such as ICT, Bohemians, Finance, where the concentration of creative class is higher (Florida, 2002; Florida et al., 2008) compared to other sectors (e.g. agriculture, manufacturing).

The second stage (Table 6.3) yielded a significant interaction between industries where creative class works and entrepreneurship. Although higher proportions of employment in the financial sector – along with Melting Pot Index – is associated with higher urban economic development, culture and ICT sectors per se have no impact on economic development in cities (see model 1 and basic, Table 6.3). Table 6.3 illustrates that banking and finance sectors performed better in cities with higher new start-up rates (Figure 6.2a–2c). Entrepreneurs with market-specific knowledge serve as a spillover of skills and education attainment for higher economic development, supporting our hypothesis one (H1).

More opportunities are seen by entrepreneurs in melting pot environments, which results in a higher regional development, was our hypothesis two (H2). Diversity and tolerance in a city, paired with the development of financial services (Florida, 2004), results in higher regional development (Table 6.3). The spillover effect of entrepreneurship within melting pot environments is valid for cities with a higher concentration of finance, rejecting our hypothesis two (H2). Furthermore, diverse cities with a higher number of immigrants from non-EU countries are associated within the same factor with the larger proportion of Bohemians. The results in Table 6.3 clearly demonstrate another interesting relationship – the Bohemians – Agglomeration entering within the same factor with a direct positive impact on economic development. Interestingly, this finding supports Shapiro’s (2006) detailed study of regional productivity growth and the quality of life, and found that roughly 40 per cent of the employment growth effect is due to quality of life, while the other 60 per cent is due to the universities and knowledge effect.

In brief, our conclusion is that new business start-ups and industries with a relatively high proportion of creative class in finance, artistic and culture and IT moderate the relationship between the proportion of people employed in those sectors and regional development (Florida, 2004; Florida et al., 2008; Boschma and Fritsch, 2009). The interaction effect is highest in the finance and banking sectors (0.34) and lowest in the ICT sector (0.02) (see Figure 6.2). It is also positive and significant for the culture sector. Interestingly, employment in the finance and banking sector has both direct and indirect impacts on economic development, although entrepreneurship reinforces it. As shown in Figure 6.2, creative class in ICT sector, culture and finance is related positively to economic development proportionally, conditional on an increase in the rate of new
Table 6.3  Regression results, city GLS cross-sectional model

Interaction with industry

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**Note:** Level of statistical significance is *** $p < 0.1$; ** $p < 0.05$ and * $p < 0.01$. Country controls are suppressed to save space. Standard errors are clustered by country to deal with spatial autocorrelation. Standard errors clustered by country and robust to heteroscedasticity are in parentheses. Standard errors for countries are suppressed to save space. Country controls are applied in all models excluding basic.

**Source:** Authors’ calculations.
business start-ups in a city. Cities that do not rely on the public sector for employment and have a higher proportion of retail industry may have lower economic development rates.

5. DISCUSSION

However, few efforts have attempted to understand the mechanisms that spill over knowledge and skills (Lucas, 1988; Florida et al., 2008; Audretsch and Keilbach, 2007; Acs et al., 2009). This study’s contribution to the entrepreneurship and regional literature lies in understanding the role of entrepreneurship as a spillover of skills and knowledge embodied in the creative class across various sectors for economic development. Using the PCA method, this study provides empirical evidence that tolerance, human capital, amenities, agglomeration economies and industry mix with relatively high and low dominance of creative class need not operate exclusively or in competition with each other. Rather, our analysis suggests that they are likely to have complementary effects on the geographic distribution of economic development in Europe (Bohemians and agglomeration; melting pot and finance industry) with entrepreneurship playing a key role in spilling over creative class skills.

Also, there may be reasons to believe that some of these drivers of economic development are related to city size (Glaeser et al., 2010; McGranahan and Wojan, 2007), as for example ‘tolerant cities’ have formed a joint factor with agglomeration economies. Larger regions, by virtue of their size and market reach, may be able to support more entrepreneurship, but also diversity and internationalism (Florida et al., 2008). Our other important findings are the following.

First is the complementary direct impact of human capital, melting pot environment, Bohemians and knowledge-based industries on urban economic development.

Second, entrepreneurship serves as a conduit of skills and talent embodied in the creative class. New firm start-ups serve as a catalyst for promoting economic development and spillover of creativity in industries where the creative class is dominant (e.g. finance, ICT and culture). Policy-makers and company managers looking for mechanisms to boost economic development in regions should be aware of entrepreneurship as a conduit of creative class skills for higher economic growth (Stephens et al., 2013).

Our findings support the argument that large agglomeration economies are likely to be melting-pot environments with openness, diversity and tolerance in the first place. Our hypothesis states there is no ‘magic bullet’ for regional economic development, as we found many complementary
factors contributing to economic development, with entrepreneurship as a moderator of creative-class skills and knowledge. At the same time, entrepreneurial activity does not complement a melting-pot city environment, with the exception of cities with a high share of employment in a financial sector. Wealthier and bigger cities have a higher proportion of migrants hunting for jobs, new ideas and diversity.

NOTES

1. Larger urban zone (LUZ) is a spatial unit approximated using NUTS level 3 data, which corresponds to the administrative region surrounding the given city. During this chapter’s writing, several of the included variables were not available in LUZ spatial units.

2. UNESCO International Standard Classification of Education (ISCED) facilitates comparisons of education statistics. Tertiary education comprises ISCED levels 5, 6, 7 and 8, which are labelled as short-cycle tertiary, bachelor or equivalent, master or equivalent and doctoral or equivalent, respectively.

REFERENCES


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7. Start-up rates, entrepreneurship culture and the business cycle: Swedish patterns from national and regional data*

Martin Andersson

1. INTRODUCTION

In her well-known book comparing California’s Silicon Valley and the Route 128 corridor outside of Boston, Anna Lee Saxenian analyzes why the two regions embarked on such different development paths. While both regions had a historically strong concentration of knowledge- and technology-intensive sectors and bright prospects for a resilient economic development, they developed along different trajectories after the crisis period in the mid-1980s. Silicon Valley continued to flourish, whereas Route 128 declined. Saxenian maintains that one important explanation for the divergent performance of the regions is rooted in differences in regional entrepreneurship culture. The following statement from an entrepreneur with experience from both regions may serve as a case in point (Saxenian, 1994, p. 63):

"In Boston, if I said I was starting a company, people would look at me and say: ‘Are you sure you want to take the risk? You are so well established. Why would you give up a good job as vice president at a big company?’ In California, I became a folk hero when I decided to start a company. It wasn’t just my colleagues. My insurance man, my water deliverer – everyone was excited. It’s a different culture out here.

A Swedish example of such a locally embedded entrepreneurship culture is the so-called ‘Gnosjö-spirit’ (cf. Wigren, 2003). This spirit is widely recognized in Sweden and is even listed in the Swedish National Encyclopedia. It is described as follows therein (author’s translation):

"The Gnosjö spirit refers to the enterprising culture that prevails in the municipality of Gnosjö and its neighbors in the county of Småland. In this region, self-employment is a way of life that dominates the local community, which..."
for instance implies that the local authorities, banks, and trade unions conform their way of working to the way the enterprises work.

Examples along these lines illuminate the quite common argument that locally embedded values and attitudes towards entrepreneurship exert a strong influence on the rate and level of entrepreneurial activity in regions. The concept of regional entrepreneurship culture aims to capture such phenomena, and refers in a general sense to the level of social acceptance and encouragement of entrepreneurs and their activities in a region (Fritsch and Wyrwich, 2012).

In this chapter I discuss regional entrepreneurship culture as a source of persistent differences in regional rates of new firm formation, and present a number of empirical regularities for Sweden to illustrate the empirical relevance of the main arguments. Using Swedish data on rates of new firm formation across regions over time, I demonstrate the association between start-up activity and the business cycle as well as how persistence in regional start-up rates was affected by a major economic crisis for the case of Sweden.

The chapter is organized as follows: in Section 2, I provide a brief background to the interest in regional entrepreneurship culture and discuss defining characteristics of culture (in particular its persistence over time). I also assess the empirical relevance of the concept in a Swedish context using data on regional start-up rates in Sweden. Section 3 presents the main patterns as regards new firm formation rates in Sweden over time. A main focus here is on how start-up rates varied during the large recession in Sweden in the early 1990s. In Section 4, I focus on regional variations in start-up rates in Sweden during the crisis period and link this to the discussion of an entrepreneurship culture. Section 5 concludes and discusses some general lessons for policy.

2. REGIONAL VARIATION IN START-UP RATES AND ENTREPRENEURSHIP CULTURES

2.1 Regional Heterogeneity in Start-up Rates

While the idea of regional entrepreneurship culture is not new (Hoselitz, 1957; Johannisson, 1984; Davidsson and Wiklund, 1997), interest in this phenomenon has increased in recent years. One reason for this is a large and growing literature documenting substantial variations in rates of new firm formation across regions, although the regions are embedded in the same national institutional environment (Audretsch and Fritsch,
1994; Armington and Acs, 2002; Bosma et al., 2008). Within Sweden, for instance, the cross-regional variations in start-up rates amount to well over a factor of 5.3

This is illustrated in Figure 7.1, in which Swedish municipalities are ranked for 2007 in descending order according to their start-up rate. The solid line shows that the number of new establishments per 10,000 inhabitants (16–64 years of age) in Swedish municipalities ranges from nearly 300 to just over 50. As indicated by the horizontal dashed line, the Swedish average amounts to about 130 new establishments per inhabitant.

The existence of regional entrepreneurship cultures is one theoretically plausible explanation for these spatial variations in entrepreneurial activity. But there are of course various reasons for regional variations in start-up rates – entrepreneurship culture is just one of several possible explanations. Moreover, a general issue with concepts such as conventions, informal rules, values and attitudes is that they are hard to measure.

Glaeser (2007) presents three different theoretical perspectives that, in addition to regional entrepreneurship culture, may explain why regions differ in entrepreneurial activity:

- **Supply of entrepreneurs**: Individuals may be more or less entrepreneurial due to factors such as age, education, social background or choice of industry. If more ‘entrepreneurial’ individuals orient
themselves systematically towards certain regions and sectors, we will observe sharp regional differences in the supply of entrepreneurs and consequently differences in regional start-up rates.

- **Inputs for new firms:** Regions may differ in terms of availability of inputs, such as venture capital, decentralized input suppliers, and supply of labor with various specializations and experiences.

- **Customers:** A large and growing local demand may stimulate new firm formation. This may be particularly important for start-ups in services sectors for which local demand is important. Another argument is that density of customers in a region may stimulate interaction between suppliers and customers, which in turn may foster ideas for new ventures.

But even after controlling for the kind of observable supply- and demand-side regional characteristics listed above, one typically finds that significant regional differences remain. Such unexplained (or ‘residual’) regional variations in start-up rates across regions may in principle be attributed to entrepreneurship culture.

### 2.2 Persistence, Time Scales of Change and Regional Entrepreneurship Culture

The main empirical support for entrepreneurship culture is, however, not regional variations in start-up rates per se. It is instead that longitudinal analyses reveal a high persistency in these variations over time.

Figure 7.2 presents the relationship between the start-up rate in 2007 and in 1987 across Swedish municipalities, that is, a time span of two decades. It is clearly the case that there is persistence in the geography of start-up rates. The main pattern is that municipalities with high start-up rates today are typically those that had high start-up rates two decades ago. Indeed, a simple linear estimation of the relationship in Figure 7.2 shows that the start-up rate 20 years ago ($L20.\text{Start}_\text{up} \_\text{rate}$) is capable of accounting for about 50 percent of the variance in start-up rates across municipalities today ($\text{Start}_\text{up} \_\text{rate}$).

This pattern is not simply an artifact of the comparative stability over time of the three sets of determinants discussed previously. The influence of previous start-up rates is robust when controlling for other factors that may influence start-up rates. In Andersson and Koster (2011), we employ Swedish data and estimate a dynamic panel model including three lags of the start-up rate, while controlling for observable regional supply- and demand-side characteristics as well as unobserved regional heterogeneity.\(^4\)

We find that the lagged start-up rates are statistically significant,
Innovation and entrepreneurship in the global economy

Illustrating that previous start-up activities have an effect on current start-up activity in a municipality after controlling for other determinants of start-ups. The results also confirm the explanatory role of supply- and demand-side characteristics. We find that the general educational level of employees, market size and the share of services in the local industry contribute to a municipality’s start-up rate. The estimated impact of the employment rate and the regional income level is generally negative, but the statistical significance of the parameter estimates is weak. This may be explained by the fact that higher employment rates generate fewer necessity-based start-ups, and that higher income levels increase the opportunity cost of starting a new business and becoming self-employed.

Why is this type of robust persistence of regional variations in new firm formation rates often interpreted as evidence of entrepreneurship culture? Culture is by definition a phenomenon that changes in slow processes. Figure 7.3 is adapted from Williamson (2000), and outlines different types of institutions and their time scale of change. Williamson argues that social ‘embeddedness’ is the highest level of institutions and that ‘this is where the norms, customs, mores, traditions, etc., are located’ (p. 596).
Such informal institutions change very slowly, on the order of centuries or millennia. They also impose constraints on other (formal) institutions as well as the general workings of the economy, indicated by the solid arrows in the figure. Resource allocation and employment in the economy change continuously, and on a much faster time scale than institutions.

Williamson’s scheme is a useful starting point for a discussion and characterization of regional entrepreneurship culture. Based on Figure 7.3, a regional entrepreneurship culture may be defined as spatially localized informal institutions that have to do with the general social acceptance and encouragement of entrepreneurs and their activities in a region. It is thus a top-level (informal) institution, influencing the rate of entrepreneurship activity in a region.\textsuperscript{5}

If informal institutions such as regional entrepreneurship cultures are historically rooted and evolve in slow processes over time, so should the
Innovation and entrepreneurship in the global economy

phenomena dependent on them. The time scale of change is a key characteristic of entrepreneurship culture, making it distinct from other types of determinants of regional start-up rates. At a given moment in time, the entrepreneurship culture may be thought of as a ‘gift from the past’, influencing current entrepreneurship activity.

Williamson (2000) suggests that the effects of informal institutions are transmitted to the institutional environment and governance structures. This is not necessarily the case for entrepreneurship culture in regions that often have the same overall institutional environment (at least if the regions under consideration belong to the same nation). A regional entrepreneurship culture can have a direct impact on entrepreneurship activity, such as a ‘social’ encouragement of individuals to consider entrepreneurship as an alternative to regular employment. This is indicated by the arrows connecting the top-level embeddedness with resource allocation and employment.

But even if regions in a country are exposed to the same national institutional and regulatory environment, there may be regional differences in the way in which different regulations are implemented. In regions with a strong entrepreneurial culture, for example, a given set of regulations from central government may be interpreted and implemented in a more ‘business-friendly’ way than in other regions. Moreover, the entrepreneurship culture in a region may also have an impact on bureaucratic procedures, *inter alia* the procedures for obtaining licenses from the local government to open a new store or establish a new warehouse in the region. Such bureaucratic procedures include handling speed, attitudes of local government and the general administrative burden.

A historically rooted social acceptance of entrepreneurship in a region may thus influence entrepreneurship in a direct way, but also in an indirect way through a long-term influence on the ‘formal rules of the game’ in the region as well as the ‘play of the game’.

2.3 Feedback and Response Mechanisms – a Self-reinforcing Entrepreneurship Culture?

It is in general difficult to pin down the origins of informal institutions such as entrepreneurship cultures. Williamson (2000, p. 597) conjectures that many informal institutions ‘have mainly spontaneous origins – which is to say that deliberative choice of a calculative kind is minimally implicated. Given these evolutionary origins, they are “adopted” and thereafter display a great deal of inertia’.

Evolutionary theory would suggest that, sparked by some historical context or event, a regional entrepreneurship culture develops in a
self-reinforcing way over extended periods of time. A critical ingredient in this kind of theoretical frame is the existence of feedback (or response) mechanisms.7

Feedback mechanisms imply interdependence, so that a region’s entrepreneurship culture is not only a determinant but also in part a product of entrepreneurial activity over long time horizons (cf. North, 1990). This kind of effect has been labeled ‘institutional hysteresis’ (Martin and Sunley, 2006), and is in a general sense motivated by spatially bounded learning and externality phenomena.

How can we understand feedback mechanisms in the context of regional entrepreneurship culture? The literature typically emphasizes ‘entrepreneurial learning’, and the role of imitation and entrepreneurial role models in such processes. I elaborate on this perspective below.

Recognizing and acting on business opportunities are inherently processes at the individual level, but the context in which these processes manifest themselves is important in shaping individual responses (Verheul et al., 2001). Guiso and Schivardi (2005) argue that entrepreneurial talent is not innate and maintain that when more entrepreneurs are active in a region, people will have greater opportunities to acquire entrepreneurial skills. According to their framework, an individual’s accumulation of entrepreneurial skills is partly a function of the regional intensity of entrepreneurs.

Entrepreneurial role models have indeed been shown to have a positive impact on the propensity of people to start new firms (Aldrich, 1999; Blanchflower and Oswald, 1998; Arenius and Minniti, 2005). Knowing an entrepreneur and having an entrepreneur in the family are good predictors of entrepreneurship. Entrepreneur role models not only assist in developing entrepreneurial skills; they are also a sign of the social acceptability of entrepreneurship. In addition, existing entrepreneurs may serve as bellwethers of certain business opportunities that imitative entrepreneurs may follow (Baumol, 1993). As such, this means that the recognition of opportunities is also influenced by role models. At the regional level, a wide availability of role models may thus generate ‘demonstration effects’, such that potential entrepreneurs are stimulated to develop an idea in the form of a new firm.8

Entrepreneurial learning is an example of a feedback mechanism, and is strongly connected to historical rates of new firm formation. Where are role models for potential entrepreneurs abundant, if not in regions with a history of high start-up rates? A region that for some reason has had a strong new firm formation in the past will have greater opportunities for entrepreneurial learning, stimulating current start-up activity. The level of entrepreneurship today then influences the regional density of role models of future entrepreneurs, as well as the general social
acceptance of entrepreneurship. This kind of effects illustrates how a regional entrepreneurship culture, through feedback effects, may evolve in a self-reinforcing way over extended periods of time. Feedback effects also provide further understanding of why the entrepreneurship culture of regions is persistent.

2.4 Swedish Evidence of a Self-reinforcing Entrepreneurship Culture

Are there any empirical regularities supporting the idea of a self-reinforcing entrepreneurship culture? In Andersson and Koster (2011), we try to capture such an effect empirically, using data for Sweden. We argue that the existence of feedback effects, promoting an entrepreneurship culture that is self-reinforcing, should imply that the strength of persistence in start-up rates is particularly marked in regions with high historical entrepreneurial activity. Feedback effects help to sustain and develop an entrepreneurship culture, providing an enduring advantage in particular for regions that have had high start-up rates in the past. These regions are most prone to self-reinforcing development.

We tested this hypothesis on Swedish data spanning a decade of start-up rates across Swedish municipalities, using transition probability analysis and quantile regression techniques. Transition probability analysis examines whether the likelihood of switching ranks, in terms of the regional level of start-up rates in a given period, is related to the previous rank. The quantile regression technique allows us to test whether the effect of lagged start-up rates on current start-up rates depends on the levels of start-up rates across regions. The empirical counterpart to our hypothesis is that regions with higher start-up rates are more likely to maintain their position, and the effect of past start-up rates is higher for regions with higher rates of start-ups.

We find support for our hypothesis. The persistence in regional start-up rates is stronger for regions with higher levels of start-up activity. Figure 7.4 is reproduced form Andersson and Koster (2011), and shows the estimated marginal effect of start-up rates in 1994 on current start-up rates (2004) using the quantile regression technique. It is clear from the figure that the estimated marginal effect of the start-up rate a decade ago is larger, the higher the level of start-up rate. This finding has also been confirmed in other studies (e.g. Fritsch and Wyrwich, 2012). The empirical regularities with regard to the strength of persistence in regional start-up rates are thus consistent with the idea of a regional entrepreneurship culture evolving in a self-reinforcing manner.
3. START-UP ACTIVITY OVER THE BUSINESS CYCLE

A localized entrepreneurship culture historically embedded in a region should also manifest itself during changes in economic conditions, such as over the business cycle. Fritsch and Wyrwich (2012) illustrate for Germany that there is persistence in start-up rates across regions over periods as long as 80 years – a period during which there have been several significant disruptions.

There are no comparable historical regional start-up data for Sweden, but available data show a significant downturn in the Swedish economy at the beginning of the 1990s. During the period 1991–93, for example, the average yearly growth of GDP and GDP per capita amounted to −1.5 percent and −2.2 percent, respectively. The average yearly growth in unemployment during the same period amounted to about 3 percent. Hagberg and Jonung (2005) maintain that the loss in employment in the 1990s crisis is the largest one ever recorded in Sweden, with an employment loss of almost 17 percent between 1990 and 1994.
How does the rate of start-ups change over such drastic economic swings? There are two basic perspectives on how new firm formation changes over a business cycle. On the one hand, an economic downturn may deter the rate of new firm formation because of fewer business opportunities when the general level of demand in the economy falls. On the other hand, a recession may imply that more people would be pushed into entrepreneurship. Economic downturns can also intensify change processes and creative destruction. A crisis may, for instance, imply that resources are reallocated, that relative prices change and that ‘equilibria’ are disturbed, which stimulate profit opportunities for new businesses (Braunerhjelm and Thulin, 2010). Economic crises can, in other words, stimulate opportunity- as well as necessity-based entrepreneurship.

Figures 7.5 through 7.8 present the relationship between GDP growth and start-up rates in Sweden, in total as well as for broad sector categories. Start-up rates are consistently measured as the number of new establishments per inhabitant 16–64 years old, and the figures report, for each year, the percentage deviation from the mean start-up rate over the whole period, that is, 1987–2003 for total start-up rates and 1990–2003 for start-up rates in broad sector categories. GDP is measured in growth rates for each respective year.

I consider two different types of start-ups: (i) those involving individuals who were unemployed the year before entry; and (ii) other start-ups. These two categories broadly distinguish opportunity- from necessity-based
Figure 7.5 presents the relationship between GDP growth (measured on the right vertical axis in percentages) and opportunity- and necessity-based start-ups, where the respective start-up rate is measured on the left vertical axis and presented as the percentage deviation from its mean value over the whole period (1987–2003).

The main patterns in Figure 7.5 are as follows:

- The 1990 crisis was preceded by high rates of both opportunity- and necessity-based start-ups. Opportunity-based start-ups are distinct in that they rose quite sharply in the years immediately before the crisis set in.
- Opportunity- as well as necessity-based start-ups responded to the economic downturn between 1991 and 1993. Both types of start-ups fell during the crisis years.
- Necessity-based start-ups increased significantly in 1994, reflecting that many individuals became unemployed during the economic downturn and tried new firm formation as an escape from unemployment. When GDP growth recovered after the crisis, necessity-based start-ups fell consistently.
- There is no comparable rise in opportunity-based start-ups in association with the crisis. Opportunity-based start-ups instead show a relatively steady but slow increase after the crisis as the economy recovered.

These patterns are broadly consistent with economic downturns being associated with less opportunity-based start-ups, for instance due to a fall in general level of demand in the economy. That opportunity-based start-ups yet increase shortly after a crisis may be due to profit opportunities associated with reallocations, price changes and structural adjustments in the economy. Economic downturns and higher rates of unemployment also appear to push individuals to (necessity-based) entrepreneurship.

Figures 7.6 through 7.8 present the same relationships for start-ups in (i) agriculture, fishing and extraction sectors, (ii) manufacturing sectors and (iii) private services sectors, respectively. These figures span 1990–2003. The main patterns in Figure 7.5 also hold for the different sector aggregates. For all sectors there is a sharp decline in start-ups between 1991 and 1993, followed by a significant increase in necessity-based start-ups in 1994. Agriculture, fishing and extraction as well as manufacturing show a declining or modest development in start-ups during the period of recovery after 1994 (Figures 7.6 and 7.7). It is instead in private services sectors
Figure 7.6 GDP growth and start-up rates in agriculture, fishing and extraction sectors, 1990–2003

Figure 7.7 GDP growth and start-up rates in manufacturing sectors, 1990–2003
Start-up rates, entrepreneurship culture and the business cycle

that opportunity-based start-ups show a clear increase after the crisis at the beginning of the 1990s (Figure 7.8). This reflects the general shift from manufacturing to services sectors that accelerated in Sweden after the crisis, such that entrepreneurial opportunities increased particularly in private services sectors. Indeed, an increasing fraction of all start-ups started in services sectors during the period after the recession, 1991–93.

4. DOES THE GEOGRAPHY OF ENTREPRENEURSHIP CHANGE OVER THE BUSINESS CYCLE?

The effects of the economic crisis in Sweden were not uniform across regions. Some lost several thousands of jobs, whereas others where only marginally affected.

Figure 7.9 illustrates the distribution of the percentage change in employees between 1990 and 1993 across Swedish municipalities. The percentage change in employees goes from marginally positive to a fall of almost 25 percent. A number of municipalities show a modest decline in employment, whereas some lost about a fifth or even a quarter of their employment.
Innovation and entrepreneurship in the global economy

Did the spatial variation in the effects of the economic downturn have any impact on the spatial distribution of start-up activity? If different municipalities were hit differently, it is conceivable that the crisis had an impact on the spatial distribution of start-ups. On the other hand, as argued earlier, an entrepreneurship culture should, because of its slow change and historical embeddedness, survive even major changes in the general economic environment.

To illustrate these questions for Sweden, I compare the spatial distribution of the rates of new firm formation in four different time periods:

- 2004–07: recent times
- 1991–93: crisis period

The main idea is to illustrate to what extent the crisis had an impact on the spatial distribution of new firm formation.

I begin by presenting the overall distribution of the average rates of new firm formation across Swedish municipalities in the four different time periods. Figure 7.10 presents the estimated kernel density of opportunity- and necessity-based start-up rates, respectively.

Starting with the opportunity-based start-ups (upper figure), the pre-crisis spatial distribution (1987–90) was less concentrated, with a higher mean start-up rate. This is evident from the curve being positioned to the right of the others, and is consistent with a higher level of...
opportunity-based start-up rates in the years immediately before the crisis, as reported in Figure 7.5.

During the crisis period (1991–93) and in the following years (1994–97) the distribution becomes more concentrated and moves to the left as the average rate of start-ups falls. The distribution for 2004–07 is positioned to the right of the distribution for the crisis years as well as the immediate post-crisis years, but its shape remains roughly invariant. A similar pattern is observed for necessity-based start-ups, though the change in the concentration and the right tail of the distribution during the crisis are much more significant.

One way to appreciate the main patterns in Figure 7.10 is that the pre-crisis period was a ‘bubble period’ inspiring entrepreneurial endeavors.
(opportunity- as well as necessity-based) in the whole economy, with a less concentrated spatial distribution of start-ups as a result. When the bubble burst at the beginning of the 1990s, the rate of start-ups then generally declined and became more spatially concentrated.

While illustrating the overall spatial distribution of rates of new firm formation, the estimated kernel densities in Figure 7.10 do not give information on the position of different municipalities in the distributions in the different time periods. In principle, a distribution can remain invariant over time although the different municipalities change positions in it.

In order to test if regional start-up rates are persistent over the business cycle in the sense that the municipalities keep their position in the (spatial) distribution of new firm formation rates over time, I do two things. First, I present Spearman rank correlation coefficients between the average start-up rate across Swedish municipalities for 2004–07 and the three other time periods, respectively. Spearman rank correlation coefficients measure how tightly ranked data cluster around a straight line and take a value between −1 and +1. Positive (negative) coefficients imply a positive (negative) association between the ranks, and a correlation close to zero means there is no linear relationship between them. Second, I estimate simple linear regressions with the average start-up rate in 2004–07 as the dependent variable and ‘explain’ this with the average start-up rate in the other respective periods. I then present the R-squares of these estimations. These R-squares give information on what fraction of the variance in the current average start-up rates across Swedish municipalities is explained by the start-up rates in the other time periods. If the Spearman rank correlation coefficients and the R-squares are high, it means that the municipalities tend to keep their position in the spatial distribution of start-up rates even in periods of significant changes in the general economic environment.

Spearman rank correlation coefficients are reported in Table 7.1 and the R-squares of the simple linear regressions are presented in Table 7.2. It is evident from Table 7.1 that the rank correlation coefficients are high and statistically significant, indicating that a municipality’s position tends to be stable even over periods of significant economic crisis. Looking at the R-squares in Table 7.2, over 70 percent of the variance in opportunity- as well as necessity-based start-up rates today is explained by the same type of start-up rates during the crisis years (1991–93) as well as the pre- and post-crisis periods.

The main conclusion is that, when the general level of start-up activity changes during a business cycle, the regional distribution of start-ups changes in terms of its concentration. But the data still suggest strong persistence in regional start-up rates over a business cycle in the sense that the position (or rank) of municipalities is rather invariant over such a period.
The start-up rates during an economic downturn can also explain a significant fraction of the variation in start-up rates in ‘normal’ times several years after the crisis. These patterns are in line with what one would expect in the presence of persistent differences in entrepreneurship cultures across regions.

5. POLICY DISCUSSION

A first remark is that policy cannot change a region’s history. Historically rooted and embedded phenomena, such as entrepreneurship cultures, must be perceived as ‘gifts from the past’. However, policy should be based on recognition of the role played by historical and cultural factors and be adapted to the circumstances in different regions.

Accepting entrepreneurship cultures means, for example, that the (local) effects of the same policy measures may be quite different depending on

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Table 7.1  Spearman rank correlation coefficients between the average start-up rate across Swedish municipalities in 2004–07 and in three other respective time periods

<table>
<thead>
<tr>
<th></th>
<th>Opportunity-based start-up rates</th>
<th>Necessity-based start-up rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994–97</td>
<td>0.79</td>
<td>0.81</td>
</tr>
<tr>
<td>1991–93</td>
<td>0.74</td>
<td>0.83</td>
</tr>
<tr>
<td>1987–90</td>
<td>0.72</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Note:  All correlation coefficients significant at the 0.01 level.

Table 7.2  Fraction of variance in the average start-up rate in 2004–07 across Swedish municipalities explained the start-up rate in three different time periods

<table>
<thead>
<tr>
<th></th>
<th>Opportunity-based start-up rates</th>
<th>Necessity-based start-up rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994–97</td>
<td>0.72</td>
<td>0.62</td>
</tr>
<tr>
<td>1991–93</td>
<td>0.63</td>
<td>0.73</td>
</tr>
<tr>
<td>1987–90</td>
<td>0.61</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Note:  The table reports the R-square from three separate regressions with the average start-up rate in 2004–07 as the dependent variable and the average start-up rate in 1994–97, 1991–93 and 1987–90 as respective independent variables.

The start-up rates during an economic downturn can also explain a significant fraction of the variation in start-up rates in ‘normal’ times several years after the crisis. These patterns are in line with what one would expect in the presence of persistent differences in entrepreneurship cultures across regions.
the region in which they are implemented. Take, for instance, the common
discussion about the magnitude of local multipliers associated with
various kinds of regional investments, such as the opening of a new plant,
upgrading or construction of highways or the establishment of a local
university. Local multiplier effects refer to the fact that these investments
often generate a larger number of jobs than those directly associated
with the activity pertaining to the investment. The reason for this is that
investments of this kind stimulate demand throughout the local economy
through expenditure linkages. A new plant in a local economy, for
instance, means a greater number of employees who demand local services
such as hairdressers and restaurants. Some multiplier effects of this kind
are materialized in the form of individuals (or entrepreneurs) acting on
new entrepreneurial opportunities provided by the investment. But the
extent to which individuals in a region do so may be linked to the entre-
preneurship culture prevailing in the region. In other words, in regions
with a ‘strong’ entrepreneurship culture – where the social acceptance
of entrepreneurship is high and entrepreneurial activities are (socially)
encouraged – the local multiplier effects of a given type of investment
may be larger because the inhabitants are more prone to recognize and
realize entrepreneurial opportunities. The message is that ‘one-size-fits-all’
policy-making at a regional scale is likely to be inefficient. Discussions
of policy measures and their expected effects should acknowledge and be
adapted to contextual factors in the regions in which the policy measures
are supposed to be implemented. Given the role played by entrepre-
neurship cultures, this appears particularly relevant in the context of policy
aimed at stimulating regional entrepreneurship.

Another lesson for policy is that historically rooted phenomena such
as entrepreneurship cultures change in slow processes, which means that
policy intended to stimulate the level of entrepreneurship in a region has
a difficult task. Short-term policies are likely to be of little help in altering
path-dependent development trajectories of regions. The characteristics
of entrepreneurship cultures provide arguments that entrepreneurship
policies should be catalytic in nature and have a long-term horizon. This
gives further support for the idea that the type of ‘framework conditions’
imposed on fiscal policy in Sweden since the crisis at the beginning of
the 1990s may also be suitable for policies pertaining to innovation and
entrepreneurship. This idea has, for example, recently been launched by
Braunerhjelm et al. (2012). Empirical evidence that entrepreneurship is
significantly influenced by durable and slow-changing cultural factors
further strengthens the idea of long-term horizons and persistence of poli-
cies intended to stimulate it.

With regard to the question which regions to aim for with start-up
policies, we argue in Andersson and Koster (2011) that there are in principle two basic contrasting perspectives. On the one hand, it could be argued that policy efforts should be concentrated on regions with an already established entrepreneurial climate, as the effects of a policy may be higher in these regions; for example more people may be willing to opt for starting new businesses. On the other hand, one could argue that policy efforts should instead be concentrated on the lagging regions, as the leading regions will be fine anyway.

Policy aiming at real influence on start-up activity and long-term development in these regions most likely needs to be catalytic in nature, able to alter pertinent slow-changing features of the regions (cf. Andersson and Johansson, 2012). Such catalytic policy measures could, for example, comprise measures to increase the in-migration of people with entrepreneurial skills and competencies through, for example, novel housing policies, or it may comprise the establishment of new R&D centers with supporting efforts to realize the entrepreneurial opportunities they give rise to. It could also focus on stressing entrepreneurial skills in education. Although the specific policy measures may differ from region to region, the main implication is that policy should focus on influencing the structural elements of a regional economy. This in turn can then influence entrepreneurial activity in the long run.

As already emphasized, these processes of change are inherently slow, and policy measures should have a long time horizon. Such policy strategies appear to have higher potential than start-up policies that focus on small adjustments of the conditions for starting new firms, for example start-up subsidies in lagging regions.

NOTES

* This chapter has been previously published in the ‘Swedish Economic Forum Report 2012’, available at: http://www.entreprenorskapsforum.se.
1. There are many different concepts in the literature that generally refer to an entrepreneurship culture (Beugelsdijk, 2007). Audretsch and Keilbach (2004), for instance, introduce the concept of entrepreneurship capital. Westlund and Bolton (2003) discuss local social capital as a driver of entrepreneurship. I use the concept of entrepreneurship culture to refer to the general level of social acceptance and encouragement of entrepreneurs and their activities.
2. Part of the presentation draws on my previous work, in particular Andersson and Koster (2011).
3. Start-up rates are measured here as the number of new establishments normalized by the regional population in the age interval 16–64.
4. Observable supply- and demand-side regional characteristics include educational level of employees, industry structure, market size and income level, as well as employment rate.
5. Entrepreneurship is indeed part of an economy’s resource allocation and employment.
Schumpeter (1934) proclaimed, for instance, that new firm formation is an important means for resource reallocation in an economy.

6. Hard data on the spatial variation in this kind of local institutions are rarely available. However, the Confederation of Swedish Enterprise publishes a yearly ranking of Swedish municipalities according to a ‘business climate’ index. One of the components of this index relates to the attitudes of local authorities and the bureaucracy associated with establishment of new plants, and these components typically show quite large variations across municipalities.

7. The dashed arrows in Figure 7.3 indeed suggest feedback effects from lower to upper levels.


9. We did not have access to longer time series in this work.

10. The underlying data refer to Swedish municipalities. The regression includes several control variables, including education intensity, market size, share of services, income, employment share and metropolitan dummy. Standard errors are bootstrapped using 3000 replications. Further details may be found in Andersson and Koster (2011).

11. The reason I report a shorter time period for the start-up rates in broad sector categories is that the sector coding system changed significantly in the early 1990s.

12. Kernel density estimation is a way to estimate the probability density function of a variable.

REFERENCES

Immigrant entrepreneurship and agglomeration in high-tech industries in the USA

Cathy Yang Liu, Gary Painter and Qingfang Wang

1. INTRODUCTION

Immigrant-owned enterprises are a vibrant component of the US economy (Fairlie, 2012; FPI, 2012; Saxenian, 1999; Wadhwa et al., 2007). According to the most recent data, 18 percent of small business owners in the USA are immigrants. Furthermore, immigrants are more likely to be small business owners than are US-born individuals (Fairlie, 2012). These businesses employed an estimated 4.7 million people, generating an estimated total of $776 billion in receipts in 2007 (FPI, 2012). In knowledge-based industries in particular, immigrants also play a vital role. Hart and Acs (2011) found that about 16 percent of their national sample of ‘high-impact’ companies in high-tech industries has at least one immigrant entrepreneur among the founding teams. In San Francisco’s Silicon Valley, 24 percent of all high-technology firms in 1998 were run by Chinese or Indian immigrants (Saxenian, 1999) and that share rose to 43.9 percent between 2006 and 2012. Nationwide, 25.3 percent of the engineering and technology companies established between 1995 and 2005 had at least one immigrant key founder. In 2005, these immigrant-founded companies collectively generated roughly $52 billion in sales and employed 450,000 workers (Wadhwa et al., 2007). However, more recent data show that immigrant high-tech entrepreneurship stagnated after 2005 (Wadhwa et al., 2012). Kerr (2008) notes the substantive increase of US patents by ethnic inventors between 1975 and 2004, especially in high-tech industries like computers and pharmaceuticals.

The spatial pattern of immigrant entrepreneurs and businesses is not even across the USA. Urban economics has highlighted the effect of agglomeration among firms, suggesting that agglomeration benefits could be especially evident among the high-skilled, small businesses, and
high-tech industries, given knowledge spillovers and scientific exchanges (Combes et al., 2010). While there have been some studies in recent years on the clustering of manufacturing firms (Glaeser et al., 2010) and on the intensity of agglomeration among female entrepreneurs (Rosenthal and Strange, 2012), no study has specifically examined the agglomeration patterns of immigrant entrepreneurship. Given the residential concentration of immigrants among metropolitan areas in both traditional and emerging destinations (Singer, 2004), we would expect a high degree of clustering among immigrant entrepreneurs, especially those in high-tech industries. It is hard to predict, however, whether residential clustering or industrial clustering would play a larger role in the generation of agglomeration economies.

This study will address the following questions:

- What are the characteristics of immigrant business owners in high-tech industries?
- How are immigrant business owners spatially distributed in the regional economy?
- What are the potential factors that shape the residential patterns of immigrant entrepreneurs across metropolitan areas?

2. LITERATURE REVIEW

2.1 Immigrant High-tech Entrepreneurship and Agglomeration

Industrial agglomeration is a well-studied phenomenon in urban economics, beginning with the seminal theoretical developments of Marshall (1920), Arrow (1962) and Romer (1986). Firms within the same industry locate close to each other in order to benefit from knowledge transfer, intellectual spillovers, labor market pooling, resource sharing as well as other network effects of scale economy. Such geographic proximity and industrial concentration foster economic growth and higher productivity. Subsequent empirical studies have tried to identify the causes, scale and benefits of industrial clustering, and have found that labor pooling has the most robust effect on agglomeration economies at both the metropolitan and sub-metropolitan levels, while knowledge spillovers positively affect agglomeration economies only at the zip-code level (Rosenthal and Strange, 2003). Entrepreneurship, measured as new firm entry, also shows spatial clustering: higher in cities with overall smaller business size and more small suppliers, lower entry costs, as well as more entrepreneurial people and relevant workers (Glaeser et al., 2010; Glaeser and Kerr, 2009).
Despite the fact that much of the empirical work on agglomeration uses manufacturing firms in their analysis, agglomeration benefits are arguably higher among the high-skilled and high-tech industries, given their reliance on knowledge spillover and scientific exchanges (Combes et al., 2010).

High-technology industries are highly concentrated in a number of metropolitan areas in the USA, identified as ‘tech poles’ by the Milken Institute’s reports on the geography of 19 knowledge-based industries (DeVol and Wong, 1999; DeVol et al., 2009). Goetz and Rupasingha (2002) documented the spatial clustering of US high-tech firms at the county level and the potential factors underlying their firm locations. Combining employment concentration with patent activity and venture capital flows, Cortright and Mayer’s (2001) detailed analysis of 14 US technology centers shows that each metropolitan area tends to specialize in relatively few products or technologies. Cities and communities act as incubators of creativity and innovation as the economic, social and policy context can shape the entrepreneurial environment and facilitate or inhibit entrepreneurial entry (Lee et al., 2004). Industrial intensity, unemployment rate and market access, among others factors, have been identified as important determinants of regional variations in firm formation (Armington and Acs, 2002) and a booming service economy is also associated with growth in self-employment (Hipple, 2004). The growth rate of incorporated self-employment is three times higher for persons with a college degree and higher, as compared to those with less than a high-school degree (Hipple, 2004). Thus a creative and diverse social environment, one that is open and tolerant, attracts human capital and produces a high level of innovation and entrepreneurship at the state (Qian and Stough, 2011) and metro levels (Hackler and Mayer, 2008).

Evidence suggests that immigrants have higher self-employment rates than comparable native-born populations (e.g. Borjas, 1986; Yuengert, 1995), though variation exists across different racial and ethnic groups and national origins (Fairlie and Meyer, 1996; Lofstrom and Wang, 2007). The contributions of immigrant entrepreneurs are particularly pronounced in the high-technology sector, a sector that is strategically important for the long-term growth of the national economy. Of all the high-impact, high-tech firms surveyed by Hart and Acs (2011), 16 percent report having at least one immigrant entrepreneur among their owners. This is in accordance with the over-representation of foreign-born workers in the US science and engineering fields in general (Stephan and Levin, 2001). These immigrant high-tech enterprises are likely to be spatially concentrated as well, given the overall agglomeration of the high-tech industry and the fact that many entrepreneurs are spin-offs from existing firms. Saxenian’s detailed descriptions of the emergence of Chinese and Indian immigrant
entrepreneurs in Silicon Valley, which together accounted for 24 percent of high-tech startups in 1998, testified to the importance of spatial clustering and network effect in this industry (Saxenian, 1999). Such concentrations are also identified in other parts of the country, including Boston’s Route 128 (Saxenian, 1994) and North Carolina’s Research Triangle Park (Wadhwa et al., 2007). Patent data also demonstrate that innovations filed by US ethnic inventors agglomerate at a much higher level than their non-ethnic counterparts, with the top five Metropolitan Statistical Areas (MSAs) hosting 45 percent of such patents in the 2000s (Kerr, 2008).

Even though these firm-level analyses hint at the spatial agglomeration of immigrant high-tech entrepreneurs, no study, to our knowledge, has systematically examined their spatial patterns across metropolitan areas at the national level and through the lens of their residential location choices. Immigrant high-tech entrepreneurs’ residential location choices may be shaped by the same types of factors affecting other immigrants, but may also be embedded in some different sets of socio-economic and politico-institutional environments in the host communities unique to entrepreneurs (Kloosterman et al., 1999).

2.2 Immigrant Location Choice at the Metropolitan Levels

Although immigrants have historically concentrated on a few gateway coastal cities, an emerging body of research has documented their changing settlement patterns from established gateway metropolitan areas to new and emerging gateways (Singer et al., 2008; Lichter and Johnson, 2009; Painter and Yu, 2008). Singer (2004) classified metropolitan areas into six major types of US immigrant ‘gateways’ by their historical and current immigrant trends, which are former gateways, continuous gateways, post-World War II gateways, emerging gateways, re-emerging gateways and pre-emerging gateways, and found that the newly emerging gateways experienced rapid growth of foreign-born population while the more established gateways saw a slower percentage growth. While many different factors underlie such location choices, Baird et al.’s (2008) inter-metropolitan-level analysis demonstrates that economic and quality-of-life factors play a more critical role than ethnic networks factors in immigrants’ inter-metropolitan settlement patterns.

Ethnically concentrated communities provide immigrant entrepreneurs with a stable consumer base for ethnic goods, recruitment channels for ethnic suppliers and workers, easy access to credit and capital and role models in business startup (Aldrich and Waldinger, 1990; Zhou, 2004). All these are essential for nascent entrepreneurs to mobilize resources and establish businesses. However, some caution that, rather than enhancing
business opportunities, a high degree of residential segregation may create an unfavorable entrepreneurial environment due to the location of job growth in other parts of the metropolitan area (Painter et al., 2007), especially when combined with poverty concentration (Fischer and Massey, 2000). Economic structures, especially factors noted in the earlier section regarding industrial composition, economic scale, human capital and innovation capacity, are also deemed important. Wang (2010) found that metropolitan labor market characteristics, especially macroeconomic conditions and overall business structure, significantly influence self-employment patterns. It is uncertain whether immigrant networks or industrial networks will play a more dominant role in the agglomeration of immigrant high-tech entrepreneurs.

One of the very few direct empirical tests of this question is by Dahl and Sorenson (2009), who found that entrepreneurs in Denmark place greater emphasis on being close to family and friends than on regional characteristics in choosing where to locate their new ventures. Their analysis did not single out immigrants, so we do not know whether the same preference between social and economic factors applies to immigrant entrepreneurs. Kerr’s (2008) analysis using patent data in the USA suggests that the ethnic inventors weigh the benefits of being close to other inventors of their own ethnicity over those of being in ethnic concentrations.

3. DATA AND METHODOLOGY

3.1 Data

The primary data in this research are derived from the Decennial Census 2000 and American Community Survey 2007–11 combined sample (referred to as the 2011 sample). This research will use MSAs as the unit of analysis. Drawing from these two time periods will enable us to assess the growth trends of immigrant high-tech entrepreneurship over the last decade. Entrepreneurs are defined as those who are self-employed by the ‘class of worker’ question. While it is true that not all self-employed workers are entrepreneurs, Aldrich and Waldinger (1990) argue that there is not a clear alternative explanation of how ‘entrepreneurs’ are differentiated from ‘the self-employed’. Thus immigrant entrepreneurs are frequently operationalized as self-employed immigrants in empirical analysis, especially those utilizing census household survey data (e.g. Fischer and Massey, 2000; Wang and Li, 2007). In addition, a number of studies compare population-based Public Use Microdata Samples (PUMS) data and firm-based Survey of Business Owners (SBO) data, and show similar
concentration patterns between these two datasets aggregated at metropolitan or national level (e.g. Liu, 2012; Wang, 2012).

3.2 Definition of High-tech Industries

There are different ways of defining high-tech immigrant entrepreneurship. It can be defined by industry (Saxenian, 1999; Cortright and Mayer, 2001; Wadhwa et al., 2007; DeVol et al., 2009), by occupation (Saxenian, 1999) and by education and skill level. In our study, we will adopt the definition developed by Milken’s high-technology economy report (DeVol et al., 2009), which classifies high-tech firms by the new North American Industry Classification System (NAICS) codes instead of the old Standard Industrial Classification (SIC) codes. This characterization makes the distinction between high-tech manufacturing industries and high-tech service industries. A detailed list is provided in Appendix Table 8A.1.

3.3 Model Specification and Variables

In addition to descriptive statistics that show the general trends, and demographic, industrial and geographic distribution of immigrant high-tech entrepreneurship, we conducted a series of OLS regression analysis at the metropolitan area level. First, we test the association between the number of high-tech entrepreneurs in 2011 and a set of metropolitan characteristics from 2000, separately for the foreign-born and the US-born. Immigrant high-tech entrepreneurs are assessed across two broad industrial groupings: (1) pharmaceutical and medicine manufacturing and services (‘medical’ – NAICS code 3254, 3391, 6215 and 5417); and (2) high-tech manufacturing industries in computer equipment, communication and electronic engineering, and high-tech services in telecommunication, computer system design, Internet services and other related industries (‘information technology, or IT’ – NAICS code 3341, 3346, 5112, 5121, 517, 518, 5191, 5415 and 5417). The selection of industries is based on earlier studies that have identified different industrial location choices among the high-tech industries. For example, Cortright and Mayer (2001) found that high-tech employment is concentrated in only a few industry segments. Metropolitan areas that show high concentrations of high-tech employment in one technology might show very low concentrations in another technology. Finally, we test the association between the growth of high-tech entrepreneurs between 2000 and 2011 and the same metropolitan area level characteristics in 2000 to capture the change over time. The growth is measured by both the change of absolute number and of the normalized rate (per 10,000 labor force).
In this research, we are particularly interested in two sets of contextual factors measured at the metropolitan area level: demographic composition and regional base of high-tech industries; and innovation capacity. To gauge the impacts of demographic dynamics, we use the share of the foreign-born population of the total population as well as ethnic diversity. Due to a high correlation between the share of the foreign-born population and the total number of immigrant high-tech entrepreneurs in each MSA, we use the share of the foreign-born population in 1970 to address such contemporaneous endogeneity. This approach has been adopted by previous studies that use past immigration patterns to predict current settlement locations (e.g. Card and DiNardo, 2000; Partridge et al., 2009). There are also different ways to measure ethnic diversity. Following earlier literature (Alesina et al., 2000; Rupasingha et al., 2002), we use the ethnic fractionalization index to measure ethnic diversity at the metropolitan area level. This index indicates the probability that two randomly drawn individuals from a metropolitan area belong to different ethnic groups.

To capture the regional base of high-tech industries and innovation capacity, we include the percentage of high-tech industries, producer service industries, labor force with at least a bachelor’s degree, and total number of patents. Due to the high correlation among them, we conduct principal component factor analyses to create a comprehensive index. A higher value of this index indicates higher values in all four aspects: a more conducive environment for high-tech industries; and a higher capacity of innovation. In addition, we include other metropolitan area level variables that measure economic, social and demographic characteristics, and innovation capacity: (1) the metropolitan employment growth rate to capture the overall economic conditions and labor market demand; (2) the incorporation rate (defined as the number of incorporated self-employment divided by the total number of the self-employed) to measure regional economic dynamics and an overall entrepreneurial environment; and (3) the industrial structure, which includes share of manufacturing, construction, trade and social services. The identification of these variables is based on previous studies, which find that industrial intensity, unemployment rate, population diversity, human capital and market access, among others factors, are important determinants of regional variations in firm formation (Armington and Acs, 2002; Lee et al., 2004). A detailed list of variables is provided in Appendix Table 8A.2 and summary statistics are listed in Appendix Table 8A.3.
4. RESULTS

4.1 Overview: National Origin and Industrial Distribution of Immigrant High-tech Entrepreneurs

According to the 2007–11 American Community Survey (ACS), immigrant workers constitute about 19.9 percent of the total high-tech workforce, higher than their share in the total labor force across all industries, 17.1 percent. In 2000, immigrants’ share in high-tech industries was 16.7 percent and their overall labor force share was 15.1 percent. Although sampling schemes have changed between the 2000 census and subsequent ACS, results indicate a steady increase of immigrants’ participation in high-tech industries commensurate with their increasing share in the US population. Among the immigrant labor force in the high-tech industries, about 6.2 percent are self-employed in years 2007–11 and 5.5 percent for year 2000.

Table 8.1 presents the total number of immigrants in the labor force, the number in the self-employed labor force in high-tech industries for all the foreign-born, US-born, and the top ten countries of origin in high-tech industries, from 2000 to 2011 (five-year average). The immigrant labor force in high-tech industries grew much faster than their US-born counterparts, 37.2 percent versus 10.7 percent. The self-employed in high-tech industries for the foreign-born grew even faster, with a rate of 64 percent, compared to 22.6 percent for the US-born. For both time periods, half of the self-employed immigrants in high-tech industries are incorporated, a higher rate than that of the native-born labor force.

Among the top ten countries from which immigrants have entered the USA that have the largest number of labor force in the high-tech industries, there is a significant variation in rate of self-employment and its growth over time. In the period 2007–11, the national rate of self-employment in high-tech industries is 6.2 percent. The rate is around 2–3 percent for immigrants from Vietnam, Mexico and the Philippines, and 9–10 percent for immigrants from England, Iran and Canada. Since the year 2000, the total number of self-employed labor force in high-tech industries experienced a significant growth for immigrants from Colombia, China, India, Korea and Vietnam, but no growth for countries such as Iran, England, Mexico, Germany and Cuba.

Compared to their US-born counterparts, who are more evenly distributed across all the high-tech sectors, immigrant-owned high-tech businesses are more concentrated in a limited number of industries. We use the location quotient (LQ) to calculate the relative concentration of immigrant versus US-born across the detailed high-tech industrial sectors.
Innovation and entrepreneurship in the global economy

The LQ is given by \( \frac{E_i}{E_t} \left/ \frac{T_i}{T_t} \right. \), where the numerator is the share of the target group \( E \) (e.g. the immigrant high-tech labor force or business owners) in specific industrial sector \( i \). The denominator represents the percentage of all the high-tech or high-tech business owners \( T \) (in our case, the total high-tech labor force or total self-employed) in industry \( i \). If \( \text{LQ} > 1 \), this suggests that the group of interest is more concentrated in sector \( i \) when compared to the share of this sector nationally. The overall foreign-born labor force in high-tech industries is more concentrated in sectors such as semiconductors, other electronic component, magnetic and optical media (LQ = 1.6), communications, audio/video equipment (LQ = 1.4), and computer-science-related sectors (LQ = 1.3).

**Table 8.1  High-tech labor force and entrepreneurs by nativity status and national origin, 2000–2011**

<table>
<thead>
<tr>
<th></th>
<th>All high-tech workforce</th>
<th>All high-tech entrepreneurs</th>
<th>Incorporation rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
<td>2011</td>
<td>change (%)</td>
</tr>
<tr>
<td>All</td>
<td>9005136</td>
<td>10363424</td>
<td>15.1</td>
</tr>
<tr>
<td>Native-born</td>
<td>7504414</td>
<td>8304939</td>
<td>10.7</td>
</tr>
<tr>
<td>Foreign-born</td>
<td>1500722</td>
<td>2058485</td>
<td>37.2</td>
</tr>
<tr>
<td>Share (%)</td>
<td>16.7</td>
<td>19.9</td>
<td>13.5</td>
</tr>
<tr>
<td>Mexico</td>
<td>136437</td>
<td>169330</td>
<td>24.1</td>
</tr>
<tr>
<td>Vietnam</td>
<td>106164</td>
<td>115024</td>
<td>8.3</td>
</tr>
<tr>
<td>China</td>
<td>89542</td>
<td>136006</td>
<td>51.9</td>
</tr>
<tr>
<td>India</td>
<td>168896</td>
<td>339518</td>
<td>101.0</td>
</tr>
<tr>
<td>Philippines</td>
<td>99188</td>
<td>136112</td>
<td>37.2</td>
</tr>
<tr>
<td>Germany</td>
<td>56481</td>
<td>63616</td>
<td>12.6</td>
</tr>
<tr>
<td>Canada</td>
<td>51509</td>
<td>58905</td>
<td>14.4</td>
</tr>
<tr>
<td>Korea</td>
<td>32731</td>
<td>55713</td>
<td>70.2</td>
</tr>
<tr>
<td>Taiwan</td>
<td>44379</td>
<td>48723</td>
<td>9.8</td>
</tr>
<tr>
<td>Cuba</td>
<td>27088</td>
<td>33544</td>
<td>23.8</td>
</tr>
<tr>
<td>Japan</td>
<td>28575</td>
<td>32860</td>
<td>15.0</td>
</tr>
<tr>
<td>England</td>
<td>36112</td>
<td>30467</td>
<td>−15.6</td>
</tr>
<tr>
<td>Jamaica</td>
<td>20968</td>
<td>28565</td>
<td>36.2</td>
</tr>
<tr>
<td>Iran</td>
<td>25233</td>
<td>28043</td>
<td>11.1</td>
</tr>
<tr>
<td>Colombia</td>
<td>19806</td>
<td>28055</td>
<td>41.6</td>
</tr>
</tbody>
</table>

Source: Authors’ calculation of Census 2000 and ACS 2007–11 combined PUMS samples.
4.2 Spatial Distribution of Immigrant High-tech Entrepreneurship

Immigrant-owned high-tech businesses are not evenly distributed across the metropolitan labor markets. We use two metrics to summarize their relative spatial concentration as compared to the native-born population at the MSA level. We first use the Herfindahl–Hirschman Index, defined as $\text{HHI}_t = \sum_{m=1}^{M} \text{Share}_{mt}^2$, where $M$ indexes 283 MSAs and $\text{Share}_{mt}$ is MSA $m$’s share of all metro workers/entrepreneurs in period $t$. A larger HHI denotes a higher spatial concentration. The second metric is the share in the top 25 MSAs (during the 2007–11 period) of all metro workers/entrepreneurs. Though crude, this measure shows the relative dominance

Table 8.2 Industrial distribution (location quotient) of high-tech workforce and entrepreneurs, 2011

<table>
<thead>
<tr>
<th>Industry</th>
<th>All workers</th>
<th>Entrepreneurs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Native-born</td>
<td>Immigrants</td>
</tr>
<tr>
<td>Pharmaceutical and medicine</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Commercial and service industry machinery</td>
<td>1.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Computer and peripheral equipment</td>
<td>0.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Communications, audio and video equipment</td>
<td>0.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Semiconductor, other electronic component, magnetic and optical media</td>
<td>0.9</td>
<td>1.6</td>
</tr>
<tr>
<td>Navigational/measuring/medical/control instruments</td>
<td>1.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Aerospace products and parts</td>
<td>1.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Medical equipment and supplies</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Software publishers</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td>Motion pictures and video</td>
<td>1.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>1.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Internet service providers, web search portals, and data processing</td>
<td>1.1</td>
<td>0.7</td>
</tr>
<tr>
<td>services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other information services</td>
<td>1.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Architectural, engineering and related</td>
<td>1.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Computer systems design and related</td>
<td>0.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Scientific R&amp;D</td>
<td>1.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Medical and diagnostic laboratories</td>
<td>1.0</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Source: Authors’ calculation of Census 2000 and ACS 2007–11 combined PUMS samples.
Innovation and entrepreneurship in the global economy

of 25 MSAs for different population segments. The resulting statistics are presented in Table 8.3.

Based on HHI indices, immigrants have a greater spatial concentration than their native-born counterparts in all time–group combinations. Across different groups, immigrant high-tech entrepreneurs demonstrate the highest concentration, surpassing all high-tech workers and all workers. Interestingly, all indices are lower in 2011 than in 2000, suggesting a deconcentrating trend among the immigrant population that is consistent with a growing literature that documents immigrants’ dispersing settlement patterns. As for the share measures, the top 25 MSAs host up to 80 percent of all immigrant high-tech entrepreneurs as compared to about 58 percent of native-born high-tech entrepreneurs in both 2000 and 2011. These numbers are also larger than the comparable shares for all workers as well as for all high-tech workers. These results all point to overall greater agglomeration among immigrant high-tech entrepreneurs across metropolitan areas.

Table 8.4 lists the top 25 MSAs by their share of all metro high-tech entrepreneurs in 2011 and displays their total and normalized number and change over the last decade. As shown in Table 8.4, the three metros of New York, Los Angeles and San Francisco alone account for about one-third of all immigrant high-tech entrepreneurs in the country in 2011. This may not be surprising, given their historical ties as the largest immigrant gateway metros. Worthy of note is the fact that several other metros registered substantial growth over the last decade besides LA and New York. These include Atlanta, Chicago, Fort Lauderdale, Houston,
Table 8.4  High-tech entrepreneurs for top 25 MSAs

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Share (%)</td>
<td>Per 10 000</td>
<td>Number</td>
</tr>
<tr>
<td>Atlanta, GA</td>
<td>2502</td>
<td>2.4</td>
<td>9.6</td>
<td>10631</td>
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<tr>
<td>Austin, TX</td>
<td>859</td>
<td>0.8</td>
<td>9.8</td>
<td>5667</td>
</tr>
<tr>
<td>Baltimore, MD</td>
<td>1128</td>
<td>1.1</td>
<td>7.9</td>
<td>5162</td>
</tr>
<tr>
<td>Boston, MA–NH</td>
<td>2184</td>
<td>2.1</td>
<td>9.6</td>
<td>10911</td>
</tr>
<tr>
<td>Chicago, IL</td>
<td>4162</td>
<td>4.0</td>
<td>8.7</td>
<td>15268</td>
</tr>
<tr>
<td>Dallas–Fort Worth, TX</td>
<td>2191</td>
<td>2.1</td>
<td>6.8</td>
<td>12235</td>
</tr>
<tr>
<td>Denver–Boulder, CO</td>
<td>988</td>
<td>0.9</td>
<td>7.0</td>
<td>8772</td>
</tr>
<tr>
<td>Detroit, MI</td>
<td>1001</td>
<td>1.0</td>
<td>4.7</td>
<td>5405</td>
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<tr>
<td>Fort Lauderdale, FL</td>
<td>2450</td>
<td>2.3</td>
<td>25.8</td>
<td>3167</td>
</tr>
<tr>
<td>Houston–Brazoria, TX</td>
<td>2687</td>
<td>2.6</td>
<td>9.6</td>
<td>8142</td>
</tr>
<tr>
<td>Los Angeles–Long Beach, CA</td>
<td>15903</td>
<td>15.2</td>
<td>24.2</td>
<td>37966</td>
</tr>
<tr>
<td>Miami–Hialeah, FL</td>
<td>4630</td>
<td>4.4</td>
<td>37.4</td>
<td>2923</td>
</tr>
<tr>
<td>Minneapolis–St Paul, MN</td>
<td>739</td>
<td>0.7</td>
<td>4.1</td>
<td>7198</td>
</tr>
<tr>
<td>New York, NY</td>
<td>14487</td>
<td>13.9</td>
<td>15.8</td>
<td>34207</td>
</tr>
</tbody>
</table>
Table 8.4  (continued)

<table>
<thead>
<tr>
<th>MSA name</th>
<th>2011</th>
<th>2000–2011 change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Immigrants</td>
<td>Native-born</td>
</tr>
<tr>
<td></td>
<td>Number</td>
<td>Share (%) Per 10000</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Orlando, FL</td>
<td>1093</td>
<td>1.0</td>
</tr>
<tr>
<td>Philadelphia, PA</td>
<td>1581</td>
<td>1.5</td>
</tr>
<tr>
<td>Phoenix, AZ</td>
<td>1392</td>
<td>1.3</td>
</tr>
<tr>
<td>Portland, OR</td>
<td>764</td>
<td>0.7</td>
</tr>
<tr>
<td>Riverside, CA</td>
<td>1853</td>
<td>1.8</td>
</tr>
<tr>
<td>San Diego, CA</td>
<td>2492</td>
<td>2.4</td>
</tr>
<tr>
<td>San Francisco, CA</td>
<td>5627</td>
<td>5.4</td>
</tr>
<tr>
<td>San Jose, CA</td>
<td>3133</td>
<td>3.0</td>
</tr>
<tr>
<td>Seattle–Everett, WA</td>
<td>1796</td>
<td>1.7</td>
</tr>
<tr>
<td>Tampa–St Petersburgh, FL</td>
<td>1197</td>
<td>1.1</td>
</tr>
<tr>
<td>Washington, DC</td>
<td>4943</td>
<td>4.7</td>
</tr>
</tbody>
</table>

Source: Authors’ calculation of Census 2000 and ACS 2007–11 combined PUMS samples.
Immigrant entrepreneurship and agglomeration

Miami, Riverside and Washington, DC. Interestingly, the metros of Silicon Valley – San Francisco and San Jose – did not experience substantial growth. We also map out these patterns for the top 50 MSAs.

Figure 8.1 maps out the distribution of all immigrant high-tech entrepreneurs among the top 50 MSAs in 2011 and Figure 8.2 demonstrates their change between 2000 and 2011. In addition, we also include maps (Figure 8.3 and Figure 8.4) that show the geographical clustering of immigrant entrepreneurship in two separate industrial groups: medical-related and computer/IT-related and their different spatial distributions.

4.3 MSA Level Model Results

Table 8.5 presents the MSA-level characteristics associated with the number of high-tech entrepreneurs per 10000 labor force for the foreign-born and the US-born, as well as for different industries. The first two columns compare the immigrant and native-born high-tech entrepreneurs. Results suggest that a metropolitan area with a historically high foreign-born population, a higher ethnic diversity, a stronger base of high-tech industries and higher innovation capacity is more likely to have a higher level of immigrant high-tech entrepreneurship. Specifically, holding all other conditions constant, a 10 percent increase in percentage of the foreign-born in a metropolitan area in 1970 implies an increase of 5.28 self-employed immigrants in high-tech industries per 10000 labor force.
Innovation and entrepreneurship in the global economy

Figure 8.2 Immigrant high-tech entrepreneur growth by MSA, 2000–2011

Figure 8.3 Immigrant entrepreneurs in medical industries by MSA, 2011
Immigrant entrepreneurship and agglomeration

In 2007–11. An increase of 0.37 unit of the diversity index (0.37 is the average value of the diversity index, which ranges from 0.06 to 0.68 in the sample) will increase the total number of immigrant entrepreneurs in high-tech industries by 2.2 per 10,000 labor force. This suggests that increased ethnic diversity is positively related to higher probability of working in high-tech industries for the immigrant labor force. Similarly, the percentages of high-tech industries, producer services, and college graduates, and the total number of patents in 2000 (which is represented by the high-tech index) are all significant positive predictors of immigrants in the high-tech businesses.

Similar to immigrants, the total number of high-tech businesses for the US-born entrepreneurs is higher in metropolitan areas with a stronger base of high-tech industries and higher innovation capacity. However, a historical immigrant presence and ethnic diversity of the regional labor market are not significant for US-born entrepreneurs. Metropolitan areas with higher percentages of construction and social services tend to have a higher number of native-born-owned businesses in high-tech industries. In addition, a higher incorporation rate in a metropolitan area, as a proxy for lack of small businesses and a more monopolized business environment, has a significantly negative association with the number of businesses in high-tech industries in 2007–11 for the native-born. At the same time, a

Figure 8.4 Immigrant entrepreneurs in computer industries by MSA, 2011
high growth rate of employment at the metropolitan area level, which could indicate a strong regional labor market and more opportunities in the wage labor market, is negatively associated with the rate of entrepreneurship in high-tech industries for the US-born.

The next two columns show results for immigrant entrepreneurs in medical and computer/IT industries. Similar to the overall model for the entire immigrant group, a historical immigrant concentration in the metropolitan area and a strong base for high-tech industries are significant predictors for both these models. In addition, while a higher percentage of construction in a regional labor market is positively associated with a higher rate of entrepreneurship in medical industries, it is not significant for computer/IT industries.

These patterns suggest that the number of immigrant-owned high-tech businesses are highly contingent on both the regional industrial structure and immigrant/minority population. A high presence of similar industries or agglomeration of high-tech industries at the regional level signals a

Table 8.5  Regression results on MSA-level high-tech entrepreneurs in 2011 (per 10,000 labor force)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Immigrant</th>
<th>US-born</th>
<th>Immigrant</th>
<th>Immigrant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Foreign-born share</td>
<td>0.528***</td>
<td>0.177</td>
<td>0.061**</td>
</tr>
<tr>
<td></td>
<td>Ethnic diversity</td>
<td>5.966***</td>
<td>7.586</td>
<td>1.183**</td>
</tr>
<tr>
<td></td>
<td>Employment growth rate</td>
<td>−0.038</td>
<td>−0.208*</td>
<td>−0.001</td>
</tr>
<tr>
<td></td>
<td>Incorporation rate</td>
<td>−0.027</td>
<td>−0.408***</td>
<td>−0.014</td>
</tr>
<tr>
<td></td>
<td>Manufacturing share</td>
<td>−0.056</td>
<td>−0.202</td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td>Construction share</td>
<td>0.426*</td>
<td>4.132***</td>
<td>0.101*</td>
</tr>
<tr>
<td></td>
<td>Trade share</td>
<td>0.121</td>
<td>0.083</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td>Social services share</td>
<td>−0.065</td>
<td>0.320*</td>
<td>0.033</td>
</tr>
<tr>
<td></td>
<td>High-tech index</td>
<td>1.183***</td>
<td>10.690***</td>
<td>0.336***</td>
</tr>
<tr>
<td></td>
<td>Intercept</td>
<td>−1.963</td>
<td>1.867</td>
<td>−1.883</td>
</tr>
<tr>
<td></td>
<td>R²</td>
<td>0.4987</td>
<td>0.5473</td>
<td>0.1778</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>283</td>
<td>283</td>
<td>283</td>
</tr>
</tbody>
</table>

Notes:
* p < 0.05; ** p < 0.01; *** p < 0.001.
Foreign-born share is from year 1970; all others from year 2000.
High-tech index is composite variable of 4 factors: % high-tech, % producer service, % bachelor’s degree, and (ln)Number of patents in 2000.
Medical is medical and pharmaceutical industry including manufacturing, services, and R&D.
Computer is computer sciences, electronic engineering industries in manufacturing, services and R&D.
Immigrant entrepreneurship and agglomeration

favorable environment critical to creative activities. By locating in these regional labor markets, immigrant high-tech businesses may have better access to markets, financial resources, critical capabilities and skills, and institutional support that constitute an ‘entrepreneurship environment’ (Malecki, 1997, p. 164). ‘Embeddedness’ in a regional milieu that is conducive to innovation is important for both immigrant- and US-born-owned high-tech businesses.

At the same time, immigrant high-tech businesses are more likely to be located in metropolitan areas that have a higher historical share of the foreign-born population and higher ethnic/racial diversity. The positive association among these variables may be derived from several sources. First, a large number of the immigrant population directly increases the base of both potential immigrant business owners and co-ethnic labor demanded by immigrant businesses. Previous studies have found that immigrant entrepreneurs begin by working for co-ethnic firms and then move to self-employment in an ethnic enclave before they expand to wider non-ethnic markets (Iyer and Shapiro, 1999). Destinations with historically high immigration also imply more acceptable social and business norms towards immigrant-owned businesses. Over the past several decades, large immigration waves in the USA have expanded consumers’ demand and increased the purchasing power for ethnic products, thus encouraging the development of ethnic businesses in diverse areas that could also help promote ethnic businesses in high-tech sectors. In addition, a regional labor market with higher ethnic diversity and foreign-born is more likely to be open, tolerant and creative in producing high levels of entrepreneurship. This finding is consistent with previous studies on immigrant-owned businesses or ethnic self-employment in general (Hart and Acs, 2011; Wang, 2010, 2012). The overall pattern suggests that immigrant entrepreneurs in high-tech industries strategically take advantage of both classic resources favorable to high-tech industries in general and ethnic- or immigrant-bounded resources provided by a large immigrant population.

Table 8.6 examines how growth in high-tech entrepreneurs between 2000 and 2011 is associated with MSA-level characteristics for immigrants as compared to the native-born population. Model 1 tests the changes in the absolute number of self-employment in high-tech industries and Model 2 tests the changes in the participating rate of high-tech self-employment per 10000 labor force. Consistent with what we found earlier, a higher percentage of foreign-born population, higher ethnic diversity, and a stronger base of high-tech industries and higher innovation capacity (higher percentage of high-tech industries, producer services, highly educated, and higher patents) are significantly associated with a faster growth of immigrant businesses in high-tech industries, measured by the
absolute change or the rate per 10 000 labor force. For example, for a
0.37 unit increase in the values of regional ethnic diversity index in the year
2000, the number of self-employed immigrants in high-tech industries will
increase by 369 and the normalized rate will increase by 1 per 10 000 labor
force between 2000 and 2007–11. In addition, a higher share of labor force
in manufacturing industries in a metropolitan labor market is positively
associated with higher growth of immigrant high-tech entrepreneurs.
Likewise, a higher growth rate of employment and a larger share of social
services are significantly related with a larger growth of immigrant high-
tech entrepreneurs measured by the normalized rate; however, the associa-
tion with the share of constructions industries is negative.

For the US-born population, the change in the total number of self-
employment in high-tech industries is significantly related to the overall
base of high-tech industries and innovation capacity (the high-tech and
education factor). This result is consistent with the model presented
in Table 8.5. Unlike previous results, absolute growth between 2000
and 2011 for the US-born population is also significantly related to the
overall ethnic diversity in a metropolitan area, although the foreign-born

---

**Table 8.6  Regression results on MSA-level high-tech entrepreneur
growth, 2000–2011**

<table>
<thead>
<tr>
<th></th>
<th>Immigrants</th>
<th>Native-born</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Absolute 2. Per 10000</td>
<td>1. Absolute 2. Per 10000</td>
</tr>
<tr>
<td>Foreign-born share</td>
<td>43.609** 0.126*</td>
<td>28.53 −0.303</td>
</tr>
<tr>
<td>Ethnic diversity</td>
<td>996.916*** 2.688*</td>
<td>1376.853*** −3.783</td>
</tr>
<tr>
<td>Employment growth rate</td>
<td>3.601 0.062**</td>
<td>11.826** −0.028</td>
</tr>
<tr>
<td>Incorporation rate</td>
<td>5.198 0.034</td>
<td>−1.881 −0.038</td>
</tr>
<tr>
<td>Manufacturing share</td>
<td>13.286* 0.109***</td>
<td>19.309* −0.237</td>
</tr>
<tr>
<td>Construction share</td>
<td>−21.267 −0.379***</td>
<td>−10.725 0.032</td>
</tr>
<tr>
<td>Trade share</td>
<td>21.135 0.058</td>
<td>38.470* 0.529</td>
</tr>
<tr>
<td>Social services share</td>
<td>0.493 0.122*</td>
<td>0.225 0.001</td>
</tr>
<tr>
<td>High-tech index</td>
<td>137.950*** 1.082***</td>
<td>246.993*** −1.313</td>
</tr>
<tr>
<td>Intercept</td>
<td>−947.741* −5.687</td>
<td>−1176.416* 1.522</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.3251 0.1912</td>
<td>0.2587 0.0485</td>
</tr>
<tr>
<td>$N$</td>
<td>283 283</td>
<td>283 283</td>
</tr>
</tbody>
</table>

Notes:
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.
Foreign-born share is from year 1970; all others from year 2000.
High-tech index is composite variable of 4 factors: % high-tech, % producer service,
% bachelor's degree, and (ln)Number of patents in 2000.
Immigrant entrepreneurship and agglomeration

While previous studies on immigrant entrepreneurship have focused largely on small businesses in low-skilled industries, this study examines the characteristics and spatial patterns of immigrant entrepreneurship in high-tech industries in the USA at the metropolitan level. Commensurate with their increasing share in the US population, immigrants’ participation in high-tech industries as both workers and business owners has increased steadily since 2000, at a faster rate than that of their US-born counterparts. Also different from the US-born, who are more evenly distributed across all the high-tech sectors, immigrant-owned high-tech businesses are more concentrated in a limited number of industries, such as computer sciences and medical- and pharmaceutical-related fields.

Immigrant-owned high-tech businesses have different spatial concentration patterns from the US-born across the metropolitan areas. In particular, immigrant high-tech entrepreneurs are more likely to be concentrated in select metropolitan areas, although there was a slight deconcentration during the first decade of this century. While the largest immigrant gateways account for a dominant share of all immigrant high-tech entrepreneurs in the country in 2011, new immigrant destinations in the South and West have seen significant increase of immigrants in high-tech industries.

In understanding the spatial patterns across metropolitan labor markets, this study finds that, for both immigrants and the native-born, a higher number of high-tech businesses is positively associated with regional labor markets that have an overall higher percentage of high-tech industries. At the same time, higher ethnic diversity and larger share of the foreign-born population are crucial factors in attracting or fostering immigrant high-tech entrepreneurship at the metropolitan level. The combination of these results has important implications for policy makers. First, a strong climate for high-tech entrepreneurship will foster growth in this critical sector. Second, policy makers should avoid anti-immigrant policies. Because there are more high-tech immigrant entrepreneurs than in the general population, anti-immigrant policies will sharply reduce the
number of immigrant entrepreneurs who will choose to locate in an area with such policies.

It is worth noting that residential location choice at any geographic level is an endogenous process that is contingent on area characteristics but also helps shape area characteristics. Although we try to control such simultaneity through lagged models to account for the time taken for any effect to take place, we are unable to detect causal relationships. Another limitation of this study is that we have to approximate high-tech entrepreneurship with self-employment due to lack of public data at the firm level with owners’ information and their geographic identification. An important next step in this research will investigate spatial patterns at individual firm level. Future research will also investigate the benefits of agglomeration for both residential clustering and firm location. Urban economic theory is not definitive as to the location of knowledge spillovers. Most models assume that firm location and residential location is the same. However, it might be the case that knowledge spillovers happen near one’s residence rather than one’s firm location.

ACKNOWLEDGMENTS

We appreciate the financial support of the Kauffman Foundation and the Fiscal Research Center at Georgia State University (Liu) and the helpful comments from Yasuyuki Motoyama, Mark Partridge and other participants at the 2013 Uddevalla Symposium in Kansas City. Deborah Strumsky at UNC Charlotte graciously helped with patent data collection. We also thank Ric Kolenda and Xi Huang for their excellent research assistance and Casey Sloan for his GIS expertise.

NOTES

1. The calculation is given by $\text{Index} = 1 - \sum (\text{Race}_i)^2$, where Race$_i$ denotes the share of population as of race $i \in I = \{\text{non-Hispanic white, black, Asian, and Hispanic}\}$. The higher the value of the index, the greater the diversity of ethnic composition of the regional population.
2. Factor analysis statistics are available on request.

REFERENCES


## APPENDIX

### Table 8A.1  List of NAICS codes for high-tech industries

<table>
<thead>
<tr>
<th>NAICS code</th>
<th>High-tech manufacturing industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>3254</td>
<td>Pharmaceutical and medicine manufacturing</td>
</tr>
<tr>
<td>3333</td>
<td>Commercial and service industry machinery manufacturing</td>
</tr>
<tr>
<td>3341</td>
<td>Computer and peripheral equipment manufacturing</td>
</tr>
<tr>
<td>3342</td>
<td>Communications equipment manufacturing</td>
</tr>
<tr>
<td>3343</td>
<td>Audio and video equipment manufacturing</td>
</tr>
<tr>
<td>3344</td>
<td>Semiconductor and other electronic component manufacturing</td>
</tr>
<tr>
<td>3345</td>
<td>Navigational/measuring/medical/control instruments manufacturing</td>
</tr>
<tr>
<td>3346</td>
<td>Manufacturing and reproducing magnetic and optical media</td>
</tr>
<tr>
<td>3364</td>
<td>Aerospace products and parts manufacturing</td>
</tr>
<tr>
<td>3391</td>
<td>Medical equipment and supplies manufacturing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NAICS code</th>
<th>High-tech services industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>5112</td>
<td>Software publishers</td>
</tr>
<tr>
<td>5121</td>
<td>Motion picture and video industries</td>
</tr>
<tr>
<td>517</td>
<td>Telecommunications</td>
</tr>
<tr>
<td>518</td>
<td>Internet service providers, web search portals, and data processing</td>
</tr>
<tr>
<td>5191</td>
<td>Other information services</td>
</tr>
<tr>
<td>5413</td>
<td>Architectural, engineering and related services</td>
</tr>
<tr>
<td>5415</td>
<td>Computer systems design and related services</td>
</tr>
<tr>
<td>5417</td>
<td>Scientific R&amp;D services</td>
</tr>
<tr>
<td>6215</td>
<td>Medical and diagnostic laboratories</td>
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### Table 8A.2  Independent variables and definitions

<table>
<thead>
<tr>
<th>Name of variable</th>
<th>Coding strategy</th>
<th></th>
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</thead>
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<tr>
<td>Immigrant Share</td>
<td>Share of the immigrant population in 1970</td>
<td></td>
</tr>
<tr>
<td>Ethnic Diversity</td>
<td>Ethnic diversity = 1-sum(Racei)²</td>
<td></td>
</tr>
<tr>
<td>Employment Growth Rate</td>
<td>Metropolitan employment growth 00–11</td>
<td></td>
</tr>
<tr>
<td>Incorporation Rate</td>
<td>Rate of incorporation among all the self-employed labor force</td>
<td></td>
</tr>
<tr>
<td>Manufacturing Share</td>
<td>Percentage of labor force in manufacturing</td>
<td></td>
</tr>
<tr>
<td>Construction Share</td>
<td>Percentage of labor force in construction</td>
<td></td>
</tr>
<tr>
<td>Trade Share</td>
<td>Percentage of labor force in wholesale and retail trade</td>
<td></td>
</tr>
<tr>
<td>Social Service Share</td>
<td>Percentage of labor force in education, social service, art and recreation, personal service</td>
<td></td>
</tr>
<tr>
<td>High-Tech Index</td>
<td>Composite index composed of four variables: high-tech industry share, producer service share, share college degree or higher in the labor force and number of patents</td>
<td></td>
</tr>
<tr>
<td>Variables</td>
<td>Mean</td>
<td>Std dev.</td>
</tr>
<tr>
<td>---------------------------------</td>
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<td>----------</td>
</tr>
<tr>
<td><strong>Dependent variables</strong></td>
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</tr>
<tr>
<td>Rate for immigrants</td>
<td>2.73</td>
<td>3.96</td>
</tr>
<tr>
<td>Rate for US-born</td>
<td>27.48</td>
<td>15.28</td>
</tr>
<tr>
<td>Rate for medical industry</td>
<td>0.52</td>
<td>1.03</td>
</tr>
<tr>
<td>Rate for computer sciences</td>
<td>2.10</td>
<td>3.06</td>
</tr>
<tr>
<td>Absolute change for immigrants</td>
<td>143.17</td>
<td>492.82</td>
</tr>
<tr>
<td>Rate change for immigrants</td>
<td>1.28</td>
<td>3.15</td>
</tr>
<tr>
<td>Absolute change for US-born</td>
<td>291.21</td>
<td>695.89</td>
</tr>
<tr>
<td>Rate change for US-born</td>
<td>3.23</td>
<td>11.20</td>
</tr>
<tr>
<td><strong>Independent variables</strong></td>
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<tr>
<td>Foreign-born share</td>
<td>3.47</td>
<td>3.25</td>
</tr>
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<td>Ethnic diversity</td>
<td>0.37</td>
<td>0.15</td>
</tr>
<tr>
<td>Employment growth rate</td>
<td>13.10</td>
<td>10.55</td>
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<tr>
<td>Incorporation rate</td>
<td>31.80</td>
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<tr>
<td>Manufacturing share</td>
<td>11.74</td>
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</tr>
<tr>
<td>Construction share</td>
<td>6.86</td>
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</tr>
<tr>
<td>Trade share</td>
<td>15.65</td>
<td>1.80</td>
</tr>
<tr>
<td>Social services share</td>
<td>33.15</td>
<td>4.71</td>
</tr>
<tr>
<td>High-tech index</td>
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</tr>
</tbody>
</table>
9. Broadband Internet and new firm formation: a US perspective

Jitendra Parajuli and Kingsley E. Haynes

1. BACKGROUND

The idea of entrepreneurs contributing to economic growth and development is not new. According to Schumpeter (1934, 1942), entrepreneurs and entrepreneurship are important for an economy to continuously evolve. Kirchhoff (1994, 3) noted that entrepreneurship involves ‘the dynamic process of new firm formation and growth [that] creates new owners and jobs, thereby creating and distributing wealth’. Entrepreneurship is the intersection of history and new technology that leads to the discovery, evaluation and exploitation of opportunities (Acs and Audretsch, 2003).

New growth theory emphasizes the role of human capital, technological change and entrepreneurship in long-run economic growth. Lucas (1988) attributed economic growth to human capital accumulation that is endogenous to an economic process. According to Romer (1986, 1990), technological change is an improvement in the production process, and on the basis of market incentives, individuals deliberately promote technological change. Hence technological change is endogenous, and so is the related economic growth. Romer (1990) also emphasized the role of intermediate goods, innovations, patents and the stock of human capital for economic growth. Using variants of the endogenous growth model, Grossman and Helpman (1990) and Aghion and Howitt (1992) identified innovations and the profit-maximizing behavior of entrepreneurs as the drivers of economic growth.

Infrastructure in general has a positive impact on economic growth and development (Aschauer, 1989; Munnell, 1990; Prud’homme, 2005; Haynes, 2006). Although the benefits vary across industry sectors (Greenstein and Spiller, 1995; Yilmaz et al., 2001), the importance of telecommunications infrastructure cannot be overlooked, especially in today’s information economy.
2. INTRODUCTION

Various features of information and communications infrastructure make them supportive of economic, social and political dynamics. First, activities span space, and physical locations need to be end-connected for information gathering and dissemination, which can be achieved by network infrastructure such as telecommunications (Bobzin, 2006). Second, telecommunications networks are characterized by their effect and scale. Positive network effects increase the utility of a network (Katz and Shapiro, 1985), which eventually increases its scale (Arthur, 1990).

Third, information and communications services are generally available without interruptions. Because of this, various innovative business solutions, such as just-in-time production, zero-inventory models, and 24/7 marketing strategy, have been adopted by small and large firms to increase efficiency and reduce costs (Sharma, 2002). Fourth, the seamless convergence of communications and information technologies (ICTs), and the availability of high capacity and high-speed access, as well as mobility, opened new service possibilities, such as electronic commerce, online education, telecommuting and telemedicine. These electronic services have a reinforcing effect that allows for the transformation of innovative ideas into new goods and services and maintains the dynamics of innovation.

ICTs are essentially general-purpose technologies (GPTs) (Harris, 1998; David and Wright, 2003; Ruttan, 2008). GPTs are ‘characterized by pervasiveness, inherent potential for technical improvements, and innovative complementarities’ (Bresnahan and Trajtenberg, 1995, 83). They are ‘enabling technologies’ that open opportunities rather than offer complete, final solutions. GPTs evolve and spread in the economy, contribute to productivity gains and sustain long-term economic growth (Bresnahan and Trajtenberg, 1995; Lipsey et al., 2005). Harris (1998) found that information networks as GPTs facilitate trade and factor services of skilled labor, and Majumdar et al. (2010) noted that the adoption of broadband Internet as a GPT positively influences the productivity of firms by enabling better communications, high-speed business transactions and efficient organization of production activities.

The availability of the Internet opened many entrepreneurial opportunities in the USA. By the mid-1990s, the electronic marketplace witnessed the emergence of companies such as Amazon.com (retail), eBay (auction), Google (search engine and other Internet-related services), Yahoo! (Web portal), Craigslist (classified advertisements), Netflix (streaming media), and Priceline (market intermediary). Over time, many top US traditional retailers adopted Web-based services for sales, communications and customer services (Griffith and Krampf, 1998) and 90 percent of large US
Innovation and entrepreneurship in the global economy

corporations moved online for recruitment (Cappelli, 2001). Other traditional businesses, such as Dell, UPS, and FedEx (Bakos, 1998) and Wells Fargo and Citibank (Furst et al., 2001), and small and medium enterprises (Grandon and Pearson, 2004) made virtual presence a strategic necessity.

In the USA, Crandall et al. (2007) observed a positive association between state gross domestic product and service sector employment and broadband adoption. Holt and Jamison (2009) noted a positive influence of broadband deployment and adoption on the economy, but also recognized the difficulty in measuring the impact precisely because of data limitation. More recently, Mack et al. (2011) established that metropolitan statistical areas (MSAs) that have broadband access attract knowledge-intensive firms, and Kolko (2012) found a positive relationship between broadband expansion and employment growth in utilities, information, finance and insurance, professional, scientific and technical services, management of companies and enterprises, and administrative and business support services at the Zip Code Tabulation Area (ZCTA) level.

3. NEW FIRM FORMATION

In today’s information economy, information is important for performing daily business activities, such as acquisitions, marketing, recruitment and sales; furthermore, businesses need high-speed access. Thus, since broadband is an essential infrastructure of the new economy, are new firms in the USA attracted to regions that have provision for broadband Internet access?

Since physical and virtual networks favor industrial diversity, entrepreneurial spirit and resource mobilization (Nijkamp, 2003), there appears to be a synergistic relationship between infrastructure and business location. Producers are close to their suppliers because of increasing returns and transportation costs (Fujita et al., 1999), innovations are concentrated in regions with technological infrastructure (Feldman and Florida, 1994), and new businesses are located in areas with transportation services (Holl, 2004) and specialized infrastructure (Porter, 2000). Overall, the absence or inadequacy of infrastructure is likely to hinder new firm formation. Thus we expect that new firm formation and the provision of broadband infrastructure are positively associated with each other.

Several other factors influence new firm births; population growth is one of them. According to Acs and Armington (2006), population growth functions as both supply and demand variables. As population grows in a region, it supplies more potential entrepreneurs, and also increases the demand and types of goods and services. Guesnier (1994),
Audretsch and Fritsch (1994), Reynolds et al. (1995), and Armington and Acs (2002) found that regional variation in new firm formation is positively influenced by population growth. Sutaria and Hicks (2004), on the contrary, found that population growth was not positively significant in explaining firm growth. However, they accepted the modeling limitations that could not capture the expected (positive) relationship between new firm formation and population growth. Based on these arguments, we expect that new firm formation is positively related to population growth.

High income, high human capital, and experienced and creative individuals are, with time, likely to be more creative and innovative. With innovative ideas and disposable income, individuals are more likely to start new ventures. Armington and Acs (2002) and Lee et al. (2004) found a positive association between income growth and new firm births. Likewise, Reynolds et al. (1995) found that the presence of greater personal wealth and firm formation are positively related to each other, and we expect the same.

Sutaria and Hicks (2004) found a positive relationship between mean establishment size and new firm formation arising from the dependence of small firms on large firms. New firms are attracted to regions with large firms to provide goods and services and in-source various jobs that large firms find inefficient to carry out in house. On the contrary, Armington and Acs (2002) and Fritsch and Falck (2002) observed a negative association between new firm births and establishment size. According to Armington and Acs (2002), the negative association could be due to the existence of large firms and/or their branch plants that hindered the formation of new firms. Since this study is interested in examining the relationship between single-unit firm births and their association with broadband infrastructure, new firm formation and mean establishment size are thought to be negatively related.

Although the effect of unemployment was small, regions that have higher unemployment experienced higher firm births. This could be the result of desperation, in that individuals unable to find jobs started new firms (Reynolds et al., 1995). In a review of some earlier studies, Storey (1991) found both positive and negative effects of unemployment on firm formation. Audretsch and Fritsch (1994) found both negative and positive association, Sutaria and Hicks (2004) found a negative relationship, and Fritsch and Falck (2002) found no evidence of a relationship between employment rate and new firm births. Armington and Acs (2002) suggested that, because of low capital requirements, new firms are likely to start up in sectors with low rather than high capital requirements. Since there is no clear understanding of the relationship between unemployment
rate and new firm formation, the relationship between new firm formation and unemployment rate, is thought to be indeterminate.

Financial capital is necessary for translating innovative ideas into actual business ventures. Entrepreneurs accrue financial capital from various sources – personal savings, social contacts, venture capital organizations and banks. However, individuals with embedded relationships and networks in a local environment are most likely to get seed and long-term capital (Uzzi, 1999; Porter, 2000; Gompers and Lerner, 2001). Sutaria and Hicks (2004) found a positive relationship between local bank deposit per capita and new firm formation. For these reasons we believe that new firm formation and the availability of local financial capital will be positively related.

Government spending can have mixed effects on the process of new firm formation. Entrepreneurs are often willing to sacrifice low initial earnings, but findings may be quite different in highly paid and less stressful jobs (Hamilton, 2000). If well-paid and less stressful (government) jobs are readily available, individuals may be attracted to them instead of pursuing innovation and self-employment. In addition, government investment crowds out private investment in the long run (Spencer and Yohe, 1970), and government pork-barrel spending simply advances the reelection agenda of politicians instead of contributing to development (Cadot et al., 2006). On the contrary, public spending on infrastructure is positively and significantly related to productivity (Aschauer, 1989; Munnell, 1990). Government contracts and welfare payments can also increase demand for new goods and services in a region and attract new firms. Thus the relationship between new firm formation and public spending is directionally uncertain.

Saxenian (2002) and Hart and Acs (2011) suggested that regions that are culturally diverse are attractive to entrepreneurs. Lee et al. (2004) and Audretsch et al. (2010) found a significant positive relationship between cultural diversity and firm births. Thus a positive relationship between new firm formation and cultural diversity is expected.

Regional variations of economic activities can be explained by their configurations and spatial structures (Markusen, 1996; Krugman, 1998; Fujita et al., 1999). Knowledge spillover is more common in cities where local competition and urban variety encourage employment growth (Glaeser et al., 1992). New businesses form in clusters that supply specialized inputs and require specialized infrastructure (Porter, 2000). New firms that spin off from existing firms are found in close geographic proximity to their genetic parent (Arthur, 1990), and agglomeration economies are important for entrepreneurial ventures (Acs and Varga, 2005). The final expectation is that diversified and agglomerated metro
regions compared to nonmetro counties are more likely to be attractive for new firm births.

Finally, in terms of scale, it is assumed that at both aggregate (total number of new firm births) and disaggregate (number of new firm births by individual sector) levels these expectations will hold. For the disaggregate-level analyses, these expectations will be tested at the county level, but for a randomly selected set of states and for some specific sectors where available.

4. DATA AND METHODOLOGY

Many previous empirical studies have adopted two models – an ecological approach that standardizes the number of start-ups to the number of existing establishments and a labor market approach that standardizes the number of new firms to the size of labor force – to examine the process of new firm formation (Acs and Armington, 2006). Since the primary interest of this research is to examine the association between single-unit new firm births and the provision of broadband access, and not firm growth with respect to the existing establishments or the size of labor force in an economy, multiple regression models with single-unit firm births as the dependent variable will be estimated without taking into account the separate approaches.

Data for the study come from various sources. The raw, non-public single-unit firm birth data are from the Census Bureau (CB). New firm birth data at the county level were available for 2006 at the time of the study. NAICS’s sectoral data were available only at the county level and only for some aggregated (2-digit) sectors. For 2006, the county-level dataset contains single-unit firm births across the 5-digit North American Industry Classification System (NAICS). The Federal Communications Commission (FCC) provides the number of high-speed service providers by zip codes. The raw data include the number of holding companies that reported providing high-speed service to at least one customer in the zip code of interest. If one to three companies report services to at least one customer in a zip code, the FCC does not report the number of service providers in that particular zip code, but indicates that some provision exists.

The number of service providers at each zip code will be matched to its respective county by using the information on ZCTA. The online tool called Dexter, provided by Missouri Census Data Center (MCDC), is used for matching zip codes and ZCTAs. Assuming that new firms will have a wide range of broadband choices in terms of price and services, for the provision of broadband in each county, the maximum number of broadband providers for 2006 will be used as the proxy for broadband access.
Population growth is the percentage change in population, and personal income growth is the percentage change in per capita income from 2005 to 2006. Both of these indicators are obtained from the Bureau of Economic Analysis (BEA). Mean establishment size is the average number of employees in a firm in 2006 and is obtained from the CB. Other variables obtained from the CB include per capita deposit in dollars in local commercial and savings institutions in 2005, and serves as a proxy for locally available financial capital; per capita federal spending in dollars in 2006, and indicates an additional source of capital; and the share of white population as a percentage of total population in 2006 is a negative proxy for diversity.

The unemployment rate, which is the share of unemployed labor force in percentage terms, is for 2006 and is obtained from the Bureau of Labor Statistics (BLS). Rural–urban continuum, which is available from the United States Department of Agriculture (USDA), is a categorical variable based on population size and ranges from 1 to 9. A dummy variable ‘metro’ will be created using this categorical variable to separate metro (1 to 3) and nonmetro (4 to 9) counties.

Table 9.1 summarizes variables, their descriptions, expected signs based on research hypotheses, and data sources. The multiple regression model with county as the unit of observation is:

\[ \text{logsub} = \beta_1 + \beta_2 \text{logmxprov} + \beta_3 \text{popgr} + \beta_4 \text{perincgr} + \beta_5 \text{estsize} + \beta_6 \text{unemp} + \beta_7 \text{finicap} + \beta_8 \text{fedspnd} + \beta_9 \text{white} + \beta_{10} \text{metro} + \varepsilon \]

where the error term \( \varepsilon \) has its usual definition.

Since firm births and broadband service providers are count data, they are transformed to their logarithmic equivalents and are denoted by ‘logsub’ and ‘logmxprov’, respectively.

5. RESULTS

Of the 48 contiguous US states, the 15 percent random sample of states generated Colorado, Florida, Montana, New Jersey, Ohio, Oregon, South Carolina and Wisconsin. Preliminary assessment of population, income and other aggregate statistics indicated that all sample values were within half a standard deviation of national norms.

In 2006, in Colorado, Denver County had the largest number of single-unit firm births (2094). The maximum number of service providers, which is 20, was in Denver and Arapahoe counties. Hinsdale and Kiowa counties had only two single-unit firm births. Both of these counties had at most
five broadband service providers. San Juan County had the lowest number of service providers.

Although Milwaukee County in Wisconsin had the largest formation of single-unit firms (1491), there were at most 12 service providers. The county that experienced the lowest number of firm births was Menominee (2), where there were one to three providers. Both Burnett and Pepin County were served by at most five operators, and the numbers of single-unit firm births were 27 and 18, respectively.

In general, counties with a large number of operators experience a higher number of single-unit firm births. The top and bottom five counties in terms of single-unit firm births in Colorado and Wisconsin are shown in Table 9.2.

As an example, Table 9.3 shows the correlation matrix (without dummy
variables) for Colorado. In Colorado, there is a strong, positive association between single-unit firm births and the maximum number of broadband service providers. The positive association suggests that firm birth and broadband service providers move together in the same positive direction. Population growth and personal income growth are positive and moderately correlated with firm formation, and that direction of association suggests that growths in population and personal income favor new firm formation.

The association between establishment size and new firm births is small and negative. This supports the view that, as establishments become bigger, they branch out, which inhibits the birth of new firms. The unemployment rate is negatively associated with new firm births. Note that unemployment can either support or hinder firm births, and in the case of Colorado, it is likely to be detrimental to firm formation. The negative association between the provision of broadband and government spending suggests that government retirement and disability support and other kinds of payments, as well as procurements and public spending on infrastructure, hinder new firm formation, which could be due to local taxation and complacency about entrepreneurial activities.

Entrepreneurs are more likely to be attracted to regions that have the

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**Table 9.2  Single-unit births and maximum number of service providers in Colorado and Wisconsin**

<table>
<thead>
<tr>
<th>County</th>
<th>Births</th>
<th>Providers</th>
<th>County</th>
<th>Births</th>
<th>Providers</th>
</tr>
</thead>
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<td>20</td>
<td>Milwaukee</td>
<td>1491</td>
<td>12</td>
</tr>
<tr>
<td>Jefferson</td>
<td>1778</td>
<td>17</td>
<td>Dane</td>
<td>974</td>
<td>15</td>
</tr>
<tr>
<td>Arapahoe</td>
<td>1773</td>
<td>20</td>
<td>Waukesha</td>
<td>916</td>
<td>11</td>
</tr>
<tr>
<td>El Paso</td>
<td>1771</td>
<td>15</td>
<td>Brown</td>
<td>445</td>
<td>14</td>
</tr>
<tr>
<td>Boulder</td>
<td>1208</td>
<td>18</td>
<td>Racine</td>
<td>308</td>
<td>11</td>
</tr>
<tr>
<td>Hinsdale</td>
<td>2</td>
<td>5</td>
<td>Menominee</td>
<td>2</td>
<td>–</td>
</tr>
<tr>
<td>Kiowa</td>
<td>2</td>
<td>5</td>
<td>Iron</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Bent</td>
<td>3</td>
<td>5</td>
<td>Florence</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Cheyenne</td>
<td>3</td>
<td>5</td>
<td>Richland</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>Crowley</td>
<td>3</td>
<td>6</td>
<td>Buffalo</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td>Jackson</td>
<td>3</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sedgwick</td>
<td>3</td>
<td>7</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Note:* There are one to three providers in Menominee County.

*Source:* Authors’ calculations.
Table 9.3  Correlation matrix, Colorado

<table>
<thead>
<tr>
<th></th>
<th>logsub</th>
<th>logmxprov</th>
<th>popgr</th>
<th>perincgr</th>
<th>estsize</th>
<th>unemprt</th>
<th>fincap</th>
<th>fedspnd</th>
<th>white</th>
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<td></td>
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<td>-0.1985</td>
<td>-0.0454</td>
<td>-0.2541</td>
<td>-0.4161</td>
<td>0.1635</td>
<td>0.0288</td>
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</table>

Source: Authors’ calculations.
choice and volume of financial support. In Colorado, financial capital and new firm birth is small, but still positively associated. There is a strong, negative association between diversity and single-unit firm birth. This suggests that Colorado was less diverse and was not attractive to entrepreneurial individuals.

5.1 Aggregate Models

In Colorado, holding other variables constant, for a 1 percent increase in the maximum number of service providers, single-unit firm births will increase by 3.33 percent. In New Jersey and Oregon, holding everything else constant, the increase is by 1.88 percent and 2.83 percent, respectively. Since the coefficient estimates are consistent with the expectation, this suggests that new firms are attracted to regions that have broadband provision.

The coefficient of population growth is positive and significant for Colorado (0.1960), Montana (0.2436), Oregon (0.1264), South Carolina (0.1156) and Wisconsin (0.2057). Everything else constant, for a 1 percent increase in population growth, increases of about 20 percent, 24 percent, 13 percent, 12 percent and 21 percent in the number of new firm births in Colorado, Montana, Oregon, South Carolina and Wisconsin, respectively, can be expected. These findings are consistent with Guesnier (1994), Audretsch and Fritsch (1994), Reynolds et al. (1995), and Armington and Acs (2002). However, the results also suggest that these findings are not equally consistent across all states.

Personal income growth is positive and significant in Montana and Wisconsin only. In Montana, for a 1 percent increase in personal income, single-unit firm births increase by about 7 percent, *ceteris paribus*. Similarly, in Wisconsin, for a 1 percent increase in personal income, single-unit firm births increase by about 15 percent, *ceteris paribus*. Although the results are generally consistent with the findings of Armington and Acs (2002) and Lee et al. (2004), not all states experience a positive and significant relationship between new firm births and income growth.

Of the eight randomly selected states, Colorado (−0.0742), Florida (−0.0451), Montana (−0.0686), Ohio (−0.0594), Oregon (−0.1553) and South Carolina (−0.1004) each has a negative and significant coefficient on mean establishment size. In other words, all other things held constant, with an increase in mean establishment size, single-unit births are expected to decrease by about 7 percent, 5 percent, 7 percent, 6 percent, 16 percent and 10 percent in Colorado, Florida, Montana, Ohio, Oregon and South Carolina, respectively. Except for New Jersey and Wisconsin,
Table 9.4  Multiple regression models, aggregate

<table>
<thead>
<tr>
<th>State</th>
<th>Colorado</th>
<th>Florida</th>
<th>Montana</th>
<th>New Jersey</th>
<th>Ohio</th>
<th>Oregon</th>
<th>South Carolina</th>
<th>Wisconsin</th>
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<td>3.3281***</td>
<td>3.7655***</td>
<td>1.5530***</td>
<td>1.8791*</td>
<td>0.7714**</td>
<td>2.8278**</td>
<td>1.4018***</td>
<td>1.9247***</td>
</tr>
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<td>(1.0180)</td>
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<td>(0.4828)</td>
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<tr>
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<td>0.0336</td>
<td>0.2436***</td>
<td>0.1295</td>
<td>0.1042</td>
<td>0.1264**</td>
<td>0.1156**</td>
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<tr>
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<tr>
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<td>0.0677</td>
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<td>0.0086</td>
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<td>(0.0321)</td>
<td>(0.0209)</td>
<td>(0.1795)</td>
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<td>(0.0310)</td>
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Note:  Significant at * \( p < 0.1 \) level; ** \( p < 0.05 \) level; and *** \( p < 0.01 \) level.

Source: Authors’ calculations.
these findings are consistent with Armington and Acs (2002) and Fritsch and Falck (2002).

The coefficient of the availability of financial capital is positive and significant in Florida (0.0401) and Wisconsin (0.0333). All other things being equal, a US$100,000 increase in the availability of local financial capital increases single-unit firm births by about 4 percent in Florida and about 3 percent in Wisconsin. This result is consistent with the findings of Sutaria and Hicks (2004).

Federal spending, on the other hand, is negative and significant in Florida and Oregon. In Florida, an increase in federal spending by US$100,000 reduces single-unit births by about 5 percent and in Oregon by about 9 percent, \textit{ceteris paribus}. This may be the result of competition from well-paid jobs in the government sector, complacency among individuals due to grants and retirement spending, or crowding-out of private investment, as noted by Hamilton (2000) and Spencer and Yohe (1970). Government spending could also have been a political motive for re-election, as noted by Cadot et al. (2006). Federal spending is not significantly related to new firm formation when other things are held constant.

The inverse of the variable ‘white’ is the proxy for cultural diversity. It is negative and significant in three states – Ohio (−0.0890), Oregon (−0.0469) and Wisconsin (−0.0359). However, for South Carolina the coefficient of diversity is positive and statistically significant (0.0122). In other states, diversity is not significant. With other things the same, a 1 percent increase in white population reduces new firm formation by almost 9 percent, 5 percent and 4 percent in Ohio, Oregon and Wisconsin, respectively. These results are consistent with Audretsch et al. (2010) and Lee et al. (2004). On the other hand, a 1 percent increase in white population increases new firm births by almost 1 percent in South Carolina, \textit{ceteris paribus}.

The other coefficient that was positive and significant across all models except Florida and New Jersey is the variable ‘metro’. All the counties in New Jersey are metro counties, so the ‘metro’ variable was dropped. It was also anticipated that metro counties are attractive to new firms compared to nonmetro counties. In Colorado, all other things being equal, metro compared to nonmetro counties are about 17.45 percent more likely to observe new firm births. Similarly, metro compared to nonmetro counties in Oregon are 83.09 percent more likely to experience single-unit births, \textit{ceteris paribus}. The results are consistent with the earlier findings of Krugman (1998), Fujita et al. (1999) and Porter (2000), which suggested that regional spillover, agglomeration and specialized infrastructure are crucial for innovation and starting new ventures.
5.2 Sectoral Results

The aggregate new firm births data are disaggregated by sector. Since it was found that there were no new firm births in different sectors, those sectors were not included in the analysis. For the remaining sectors, the association between broadband provision and new firm births was examined and the same set of hypotheses was tested. This section presents only the models of manufacturing; finance and insurance; and real estate and rental and leasing sectors.

Manufacturing sector

In Florida and Wisconsin, with other things the same, the provision of broadband is not associated with the number of new firm formations at the county level in the agriculture, forestry, fishing and hunting sector (NAICS 11). The results suggest that firms in the agriculture sector probably do not need high-speed access for their daily operations, and that the provision of broadband may not be a critical component in starting a new venture in these sectors, at least in these states.

Table 9.5 shows the multiple regression models for Colorado, Florida, New Jersey, Ohio, Oregon, South Carolina and Wisconsin. In these models, the dependent variable is the logarithmic transformation of single-unit births in the manufacturing sector (NAICS 31–33). Except for Ohio, the provision of broadband is positive and statistically significant, ceteris paribus.

In 1997, Ohio’s manufacturing output was more than 6 percent of national manufacturing output. Although it was still more than 5 percent of US manufacturing output in 2005, the manufacturing output of Ohio rapidly declined compared to other states. Ohio seems not be an attractive region for new manufacturing start-ups, and the provision of broadband is not significant in changing that role with respect to generating births of new manufacturing firms (see Figure 9.1).

Finance and insurance, and real estate and rental and leasing sectors

Finance and insurance (NAICS 52) and real estate and rental and leasing (NAICS 53) are two major service sectors that significantly use ICT services (Greenstein and Spiller, 1995; Yilmaz et al., 2001; Crandall et al., 2007). Tables 9.6 and 9.7 show the multiple regression models for these two sectors, respectively. In the finance and insurance sector, holding other variables constant, a 1 percent increase in the provision of broadband increases the probability of new firm formation by almost 2 percent, 4 percent, 1.5 percent and 1.5 percent in Colorado, Florida, Ohio and Wisconsin, respectively. However, the provision of broadband
<table>
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Note: Significant at * p < 0.1 level; ** p < 0.05 level; and *** p < 0.01 level.

Source: Authors' calculations.
and single-unit firm births in this sector is not significantly associated in South Carolina.

The share of South Carolina’s output in national output in the finance and insurance sector was 0.66 in 1997 and 0.71 in 2005 (see Figure 9.2). However, the increase was very small. This could be one of the reasons that, even with the provision of broadband, South Carolina may not be an attractive state for starting new firms in the finance and insurance sector. Further, there could be a negative spillover resulting from the expansion of the economic sector (Yilmaz et al., 2002) such that the expansion of the finance and insurance sector in the neighboring regions could have a detrimental effect in South Carolina.

In the case of real estate and rental and leasing, except for Ohio, the provision of broadband has a positive and significant association with single-unit firm births. With other things the same, a 1 percent increase in the provision of broadband services increases firm formation by about 3 percent, 3.5 percent and 1 percent for Colorado, Florida and Wisconsin, respectively.

A number of factors could have affected new firm births in Ohio, one of which may be the declining real estate and leasing sector (see Figure 9.3). The share of Ohio’s output in national output in the real estate and rental and leasing sector was 3.33 in 1997 and went down to 2.93 in 2005.

Source: US Bureau of Economic Analysis.

Figure 9.1 Manufacturing sector output as the percentage of total US output
Table 9.6 Multiple regression models, finance and insurance sector (NAICS 52)

<table>
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<tr>
<th></th>
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<th>Florida</th>
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Note: Significant at * p < 0.1 level; ** p < 0.05 level; and *** p < 0.01 level.

Source: Authors’ calculations.

Perspective across states and sectors
In general, with other things the same, the provision of broadband services and single-unit firm births are positive and significantly associated across 2-digit NAICS sectors in eight sample states. As examples, Florida and Ohio are further qualitatively examined.

The association between single-unit firm births and the provision of broadband is not consistent across the 2-digit NAICS. In Florida, of the 16 sectors examined, single-unit firm births and the provision of broadband was positive and significant in 14 sectors. Figure 9.4 shows the outputs of three high-growth sectors in Florida – professional, scientific, and technical services (NAICS 54), wholesale trade (NAICS 42), and administrative and support and waste management and remediation services (NAICS 56) – as a percentage of US output by sector from 1999 to 2005.
In NAICS 54, for a 1 percent increase in the provision of broadband, there is about a 5 percent increase in single-unit births, *ceteris paribus*. Similarly, holding other variables constant, for a 1 percent unit increase in the provision of broadband, there is about a 4 percent increase in single-unit births in both NAICS 42 and NAICS 56. Thus, with the positive provision of broadband and single-unit firm births, new firms are likely to be attracted to or stimulated in such growing sectors.

Although the broadband data collection method was not consistent across years, the existing data suggest that Florida’s broadband adoption was increasing since 1999, as shown in Figure 9.5.

In 2005, the number of broadband lines per 100 individuals in Florida was 19.76, which is higher than the overall US lines per 100 individuals (16.95). Florida had also adopted various initiatives to promote Internet
Innovation and entrepreneurship in the global economy

**Figure 9.2  Finance and insurance sector output as the percentage of total US output**

**Source:** US Bureau of Economic Analysis.

**Figure 9.3  Real estate and rental and leasing sector output as a percentage of total US output**

**Source:** US Bureau of Economic Analysis.
Source: US Bureau of Economic Analysis.

Figure 9.4 Outputs of three sectors in Florida as a percentage of total US output

Source: Federal Communications Commission.

Figure 9.5 Broadband lines per 100 individuals
Innovation and entrepreneurship in the global economy

Moreover, it was found that broadband services in Lake County, Florida were beneficial to businesses (Ford and Koutsky, 2005). In essence, Florida was a large and diversified economy in terms of its gross state product (see Figure 9.6) and the use of the Internet was already an integral part of Florida’s economy. Thus single-unit firm births across multiple sectors were positively and significantly associated with the provision of broadband.

However, in the case of Florida, it should also be noted that firm births are significantly associated with other variables as well. In NAICS 56, financial capital is positive and significant; in NAICS 42, mean establishment size, federal spending and the diversity percentage are negative and financial capital is positive and statistically significant; and in NAICS 54 mean establishment size and federal spending are negative and financial capital is positive and significant.

Although Ohio was also a big and diversified economy (see Figure 9.6), there were only six sectors out of 15 that showed a positive and significant relationship between single-unit births and the provision of broadband. In Ohio, holding other variables constant, for a 1 percent increase in the provision of broadband, there was a 1.55 percent, 1.15 percent and 1.05 percent increase in single-unit firm births in the finance and insurance

Source: US Bureau of Economic Analysis.

Figure 9.6  Gross state products
Broadband Internet and new firm formation

231

(NAICS 52), accommodation and food services (NAICS 72) and retail trade sectors (NAICS 44–45), respectively. Even then, from Figure 9.7 it can be argued that two of these sectors were declining in terms of output. In such a case, entrepreneurs seem less likely to be attracted to start new ventures in declining sectors such as retail trade and finance and insurance. In addition, other county-level factors also contribute to firm formation. For instance, mean establishment size, unemployment rate and diversity index were negatively significant and the metro variable was positively significant in the finance and insurance sector.

6. CONCLUSION

The objective of this chapter was to describe the relationship between single-unit firm births and the provision of broadband. The aggregate-level analyses suggest that single-unit firm births and the provision of broadband are positive and significantly associated, after controlling for other variables. However, it should also be noted that factors such as population growth and urbanization are generally positively associated with new firm formation. Establishment size, on the contrary, is generally negatively associated with single-unit firm births. The asso-
The association between new firm formation and other variables varies across states.

After disaggregating firm formation by sectors and estimating the models, the results varied across sectors as well as states. In the manufacturing sector, keeping other variables constant, new firm births and the provision of broadband are positively associated except in Ohio, where the association was not significant. In the finance and insurance sector, there was no statistically significant relationship between single-unit firm births and broadband availability in South Carolina. Similarly, in the real estate and rental and leasing sector, after controlling for other variables, the association between new firm formation and broadband availability was not statistically significant in Ohio.

On the one hand, broadband Internet is an enabling technology and is important for various reasons, such as communications, marketing, selling, advertising, recruiting and networking, in today’s economic environment. Thus it is likely that regions with access to broadband services attract entrepreneurs to start their business ventures. On the other hand, it should be noted that broadband Internet is a component of economic growth, and that comparative advantage varies across regions and industry sectors. As observed in this study, in terms of new firm formation, not all sectors or regions benefit equally from broadband. Other factors, such as population, income and unemployment, are also associated with single-unit firm births. Hence regional policy formulation should take a more holistic approach by taking into account the local economic environment and not merely broadband.

ZCTA was used to match the number of providers from zip codes to counties. Since some zip codes cross county boundaries, the ZCTA-based matching may have overestimated as well as underestimated the number of providers in some counties. In future research, the intersection-based technique or any other relevant methods can be used to match providers from zip codes to counties and used in the models. However, given the size of the sample and sector aggregate, it is believed that alternative spacing will not generate significant differences with these results. Agglomeration plays a big role in new firm formation and administrative boundary adjustments are likely to have a negligible influence on the location of a new firm with respect to the provision of broadband.

Size effect was not a problem in the models. However, spatial effects were observable. In addition, because of data limitations, the issue of causality was been studied. These issues should also be addressed in the future.
ACKNOWLEDGMENT

We express appreciation to the US Department of Agriculture (Award No. 2008-55401-04487) and the US Department of Commerce/Economic Development Agency (Grant No. 99-07-13862) for support of this activity. We are also grateful to three anonymous reviewers for their constructive feedback. The authors are fully responsible for all analysis and policy interpretations associated with this work.

REFERENCES


10. When being wrong might be right: on overconfidence as an evolutionary mechanism of nascent entrepreneurs

Martin G.A. Svensson

1. INTRODUCTION

A growing body of literature has come to address the relationship between the entrepreneurial sector and the macro-economy – stating that entrepreneurship matters (cf. Wennekers and Thurik, 1999; Thurić and Wennekers, 2004; Karlsson et al., 2004; Minniti and Lévesque, 2008). The importance of entrepreneurship is reflected in a number of stylized empirical regularities. One such regularity is that companies continuously enter the market despite low probabilities of prolonged longevity (Storey, 1982, 1994; Malerba and Orsenigo, 1996; Dosi and Nelson, 2009). Another is that entrepreneurship is unevenly distributed across space (cf. Audretsch and Fritsch, 1994; Armington and Acs, 2002; Bosma et al., 2008; Grek et al., 2009). While being both interesting and puzzling, the explanation for these regularities stretches beyond self-tormenting behavior of single entrepreneurs to multilevel interactions between individual characteristics and the context in which they are played out. This chapter will specifically address this matter through the lens of cognitive biases.

A range of individual-based cognition-laden aspects such as risk propensity (Knight, 1921; Uusitalo, 2001), locus of control (Shapero, 1975) intuition (Allinson et al., 2000) and biases (Busenitz and Barney, 1997; Koellinger et al., 2007) have been argued crucial to entrepreneurship. Most often studies have overlooked the interplay of individual features and the environment (Welter, 2011), or vice versa, making the influence of entrepreneurial characteristics on local, regional and national economies somewhat blurred. The lack of such multilevel approaches is unfortunate for at least two reasons. First, entrepreneurship is an activity that largely conforms to various pressures (Staber, 2005; Baumol, 1990). Second,
small variations in individual behavior tend to multiply in social interaction (Glaeser et al., 2003). Accordingly, individual-level features need to be put in context and given primacy, as it becomes difficult to draw inferences about individuals based on aggregated data.

The purpose of this chapter is therefore to extend and, again, raise Dosi and Lovallo’s (1997) arguments of evolution and overconfidence by focusing on the mechanism explaining how a micro-level feature may initiate firm formation and affect survival rates as well as influence others’ intentions to create businesses on the local level. More specifically, as entrepreneurial activity regards suboptimal decision making in terms of non-linear processes characterized by lack of information and time-pressures (Reynolds and White, 1997), the study outlines how individuals’ limited cognitive capacities (in terms of overconfidence) may contribute to a distribution of start-ups. Moreover, such an approach also aims to deflect the categorically negative reputation of biases, as what is presumably negative for the individual may not necessarily be negative for the system in which the individual acts. In the chapter, literature on evolutionary economics, empirical evidence on start-ups and survival rates from several domains relating to industrial dynamism and entrepreneurial cognitions is intersected.

The remainder of this chapter is structured as follows. First, evolutionary theory as an overall framework is introduced. Second, the decision-making capabilities that underpin entrepreneurial decision making are reviewed, followed by accounts of various contextual conditions that influence start-ups and survival rates. Next, the influence of both individual-level features and local conditions on entrepreneurship is discussed by using an evolutionary lens. Finally, the chapter closes by discussing implications for entrepreneurs and policy makers.

2. LITERATURE REVIEW

2.1 Evolutionary Economics and Evolutionary Niches

Darwinian evolution stipulates three core mechanisms: variation, selection and inheritance (Darwin, 1859/1962; Dawkins, 1976, 1986). While evolution clearly has a biological connotation, it applies to any system that encloses the three mechanisms, where the selection mechanism is systematic and ongoing (Aldrich et al., 2008; Dawkins, 1976, 1986). Thus, according to Aldrich (1999), evolutionary theory is a candidate that offers a single coherent framework that enables understanding of entrepreneurial outcomes, the processes and the contexts that make them possible.

Evolutionary economics has evolved from the biology-based theory
into matters of economic development, focusing on, for instance, changes in technology and routines in society (Nelson and Winter, 1982). It is a history-dependent and dynamic process, but also a process infused with chance and mistakes. The random elements introduce variety that in turn is either weeded out or absorbed, dependent on their fit to the environment. Consequently, the evolutionary process also emphasizes learning and discovery – processes that typically are path dependent, moving along certain trajectories – as they are rooted in accumulated knowledge (cf. Dosi and Nelson, 1994). Thus the cognitive regularities underpinning evolution may be a result of both incremental adaptions to slowly moving processes as well as responses to unintentional, myopic and biased actions.

In order to cope with both interruption and accumulation, routines have been regarded as a core element of evolutionary theory. The routine concept spans both the individual and collective level, and can be explained as organizational skills or dispositions on how to act (cf. Hodgson and Knudsen, 2004). Such dispositions regard memory, knowledge, habits and organizational structures, implying that new organizations are less of a *tabula rasa*, but rather products that have inherited routines from parent organizations (Klepper, 2002, 2007; Klepper and Sleeper, 2005). Firms also acquire their routines from the expectations that emerge when interacting with entrepreneurs, employees, customers, investors and stakeholders (Bryant, 2012; Davidsson et al., 2006; Sarasvathy and Dew, 2005). However, the relationship may also be the reverse, as new organizations typically acquire their routines from the population of organizations they join (Aldrich and Martinez, 2001).

As routines are carried across firms, they account not only for replication, but also for variety (as only certain elements are reproduced). From this perspective, the routines of entrepreneurs become crucial for economic development; several scholars have stated that entrepreneurship centers on introducing variations or diversity (Schumpeter, 1942/2008; Breslin, 2008; Sarasvathy, 2001). While introduction of variety facilitates evolution of the system, the need for heterogeneous elements in order to recognize and absorb the variation is obvious (Witt, 2004). Thus the cognitive aspect of routines is central, not only to introduction of variety, but also to the inheritance processes of evolutionary models.

However, while evolutionary theory has been preoccupied with how the agents cognitively adapt to the environment, it is important to emphasize that the reverse is also evolution. Agents may change conditions of the environment and thereby introduce evolutionary ‘niches’ that change conditions for evolution (cf. Lewontin, 1982, 2000). Such niche construction is not an organism-driven modification of
the environment *per se*, but rather a modification of the relationship between an organism and its relative niche (Odling-Smee, 1988). Hence the term ‘niche construction’ includes habitat selection, where organisms relocate in space to modify the environments that they experience (Rosenzweig, 1991). Thus areas that become dense with entrepreneurs may influence the business climate of the region by establishing mutual norms and mindsets that change interpretation of local routines and regulations. Such change is likely to influence non-entrepreneurs negatively and nascent entrepreneurs positively. From the previous section it is clear that evolutionary theory provides core concepts that facilitate understanding of economic development. Following these concepts, the next section provides an exposé of empirical research that emphasizes entrepreneurial behavior as dependent on both individual and contextual characteristics.

2.2 Entrepreneurial Characteristics of Entrepreneurs

Entrepreneurs are argued to introduce new knowledge (variety) by reacting to uncertainties, asymmetries and transaction costs, rather than to common knowledge (Shane, 2003; Audretsch and Keilbach, 2004). Thus entrepreneurs have been argued to possess specific skills, knowledge, attitudes and preferences (Simon, 1957; McFadden, 2001), as well as personality traits. For instance, entrepreneurs have been argued to show higher need for achievement (McClelland, 1961; Collins et al., 2000), a composite of high levels of extraversion, compared to non-entrepreneurs (Roberts, 1991), together with low levels of agreeableness (Wooten et al., 1999). Additionally, a range of motivational features, such as need for independence (Vesalainen and Pihkala, 1999; Reynolds and White, 1997), increased internal locus of control (Robinson et al., 1991) and self-efficacy (Robinson et al., 1991; Baron and Markman, 1999) have also been associated with successful entrepreneurship.

Entrepreneurs also face considerable time pressures, as the window of opportunity for business ideas may quickly close. Such a condition implies that entrepreneurs are ‘boundedly rational’ individuals (Simon, 1957; March, 1994). They use imperfect information, simplifying overly complex problems into actionable solutions by using mental shortcuts. However, by adopting the view of heuristics, the entrepreneur becomes prone to a range of cognitive biases (Busenitz and Barney, 1997) – suboptimal decisions deriving from systematic cognitive distortions. A bias of particular importance to entrepreneurship is overconfidence, as it may affect both start-ups and survival rates.
Overconfidence

Overconfidence has been called the most pervasive and potentially catastrophic of all biases (Plous, 1993). It refers to miscalibration between subjective and objective confidence. In other words, regardless of prior experience, entrepreneurs would assess themselves as more likely to succeed than others, while in fact they statistically have an equal or lower chance of doing so. While knowledge in a specific domain is argued to protect against inhibited decisions, Gervais and Odean (2001) found that overconfidence increased with experience as subjects accumulated more experience. Similarly, ‘overconfident professionals sincerely believe they have expertise, act as experts and look like experts’ (Kahneman, 2011). Thus overconfidence is not easily disregarded in entrepreneurial decisions.

In order to assess overconfidence effects, Camerer and Lovallo (1999) designed experiments where subjects could forecast either positive industry profits and decide to enter and thereby confirm rational entry, or forecast positive industry profits, but underestimate entry numbers and industry profit in negative terms – which would confirm ‘blind spots’. Finally, if subjects accurately forecasted negative industry profits, yet entered anyway, an overconfidence effect would emerge. They found that when pay-offs were related to their own abilities, they tended to overestimate chances of relative success by entering. Overconfidence was even stronger when subjects self-selected into experimental conditions, aware that success depended only in part on their own skill, as others would also self-select, rendering a total loss ratio in 34 out 48 sessions. The result was partly attributed to entrepreneurs’ ‘inside view’ of handling problems (cf. Kahneman and Lovallo, 1993), where thinking about a problem means considering all that one knows about it, with special attention to its unique features rather than analyzing aggregated knowledge, such as extrapolating from statistical base rates. While experimental data support overconfidence effects among entrepreneurs, empirical survey data do so too. In a large scale survey using 1990–96 data from the British Household study, Arabsheibani et al. (2000) investigated whether self-employed individuals were over-optimistic. The results turned out to be more extreme for self-employed in comparison with employed. Self-employed were 4.6 times more likely to forecast an improvement of financial prospects but experience a deterioration than to forecast a deterioration and experience an improvement. As a comparison, the same prediction made by those in paid employment was 2.9. Thus there was tendency for excess optimism of both employed and self-employed, but it was more pronounced for the self-employed. Furthermore, a more recent study by Dawson et al. (2012) showed that those who otherwise performed equally, but migrated from employment to self-employment, overestimated financial prospects by as
much as 20 percent. Overconfidence is therefore more of a cause than an effect of learning and adaptation to markets.

On the subject of overoptimistic entrepreneurs and survival rates, Hmielski and Baron (2009) showed a negative relationship between entrepreneurs’ optimism and performance (revenue and employment growth) of their new ventures. In other words, more optimistic entrepreneurs performed worse than moderately optimistic entrepreneurs. Past experiences of creating ventures and industry dynamism moderated these effects, strengthening the negative relationship between entrepreneurs’ optimism and venture performance, implying that optimistic entrepreneurs are less likely to learn from past experiences. Moreover, Gudmundson and Lechner (2013) modelled the interplay of different cognitive biases, showing that overconfidence was the primary cause for negative survival, but that optimism and distrust influenced overconfidence at the same time as they showed conflicting influences on their own survival. Distrust facilitated survival rates, whereas optimism affected them negatively. Thus, while overconfidence may contribute to rates of entering, it also seems to be a factor that contributes highly to the failure of firms.

Other research (Aldrich, 1990; Aldrich and Martinez, 2001) has also addressed overconfidence as a version of an identification problem. Uncontrollability of counterfactual outcomes poses difficulties for research dealing specifically with effects (Manski, 2003). Overconfidence may in fact be related to a sampling problem and *ex post* rationalizations. ‘Boundedly rational’ entrepreneurs make imperfect assessments that do not perfectly match actual realizations – there is ‘noise’ in their judgmental ability. In turn, the ‘noise’ miscalibrates entrepreneurs, causing them to be too optimistic about the rate of success, and the decision to enter inevitably leads to firm failure. However, others will underestimate their true opportunity – being underconfident – so that they are less likely to enter. Thus processes and outcomes of underconfident entrepreneurs are more difficult to observe as statistics on missed opportunities are rare. At the same time, overconfident entrepreneurs become more visible in data as they are in fact those that enter. In other words, when the business environment is ‘noisy’, entry rates can be explained as the presence of systematic overconfidence among entrepreneurs as they are more likely to enter and consequently more likely to fail (Hogarth and Karelaia, 2012). However, descriptions of processes and outcomes of overconfident entrepreneurs become less valid as they lack a reference group.

While there is evidence that overconfidence affects both start-up and survival rates, the mechanism for such effects is obscure. Furthermore, while recognizing opportunities may be a trait-like disposition among entrepreneurs, such a trait is also played out in context (Verheul et al.,
2001). For instance, if certain regions show a greater density of entrepreneurs, individuals in these settings have better chances of acquiring skills associated with entrepreneurial behavior (Guiso and Schivardi, 2005). Therefore in the next subsection I account for contextual conditions of entrepreneurship.

2.3 Contextual Conditions for Entrepreneurs

Despite an emphasis on individuals' characteristics, entrepreneurship conforms to institutional, spatial, organizational and social pressures. Thus it is a path-dependent process that hinges on cognitive regularities, which slowly move towards a state of convergence and inertia. Exemplifying the various pressures that entrepreneurship is subjected to, on an institutional level, Baumol (1990) advocated entrepreneurship as dependent on ‘the rules of the game’ that different eras provide. Society tends to allocate different payoffs for productive activities such as innovation, and unproductive activities such as rent seeking or organized crime. The current Zeitgeist therefore sets the scene for both the intention to become an entrepreneur and the chances of survival as the incitements to set up and maintain one’s business depend on the dominant rules in society.

The regional level

Examples of factors at the regional level suggest that the number of new firms in the regional market, employment growth and size of the region are important determinants of firm survival (Falck, 2007). Furthermore, the influence of entrepreneurial variety is also stressed. Yet such inflow of knowledge *per se* is not a sufficient criterion for economic growth (cf. Boschma and Iammarino, 2009). A region where entrepreneurs introduce new businesses needs to have a sufficient level of absorptive capacities (Cohen and Levinthal, 1990). For instance, Buenstorf and Klepper (2009) showed that Goodrich initially located in Akron, by historic happenstance. As the company grew successful, numerous companies localized there – possibly because knowledge spillover is geographically bounded (Audretsch and Feldman, 1996). In other words, actors within the region need to be able to adapt to new knowledge according to the prevailing local culture(s). Thus the learning process associated with start-ups guides (but also restricts) entrepreneurs and companies along certain trajectories. Companies within a region become more and more homogeneous as specialization branches into cognitively related areas (Neffke et al., 2011), in turn providing for similar knowledge bases (Boschma, 2008). Empirical examples of this are to be found within the automobile industry, where new establishments emerged from engineering-related industries
as bicycle producers and carriage builders (Carroll et al., 1996; Klepper, 2002; Boschma and Wenting, 2007).

Even with a more fine-grained resolution, at the level of neighborhoods, relatedness seems to influence entrepreneurial propensity. For instance, Andersson and Larsson (2013) suggested that the density of entrepreneurs in a specific neighborhood (as measured by 1 km² grids) could explain future entrepreneurial behavior, as these areas are small enough to capture localized non-market effects, such as knowledge spillovers. However, while such findings help in describing start-up rates, they are less informative about the mechanisms underpinning the process as well as the factors affecting frequencies of exits and deaths.

**The industry level**

On the industry level, turbulence is considerably diverse between sectors, being negatively correlated with rates of innovation, advertising and capital intensity, and positively correlated with concentration and growth (Acs and Audreutsch, 1991). It appears less in the core of the industry as new firms typically enter on the fringe (Dosi et al., 1997). Small firms have been argued to replace old firms by being more efficient and as a function of MES (minimum efficient scale), and thus showing higher initial growth rates (Malerba and Orsenigo, 1994). However, it is important to differentiate between gross and net entries, since, for the large number of entries, a significant number of exits is seen within five years from entry. Thus, while gross entry is high, net entry is rather low. Surviving firms typically have a large initial size, also reflected negatively in growth rates (Acs and Audreutsch, 1991). While empirical regularities of turbulence surface at the industry level, innovation activities, entries and exits are also reflected at finer level of detail. Within micro-sectors of the industry, evolution roughly follows a life-cycle approach (Klepper, 1992). In certain industries, small firms may account for significant innovation activities and thus the number of entries is high. In terms of survival, using a Swedish example, it seems that entrepreneurs’ cognitive relatedness facilitates survival of the firm. Andersson and Klepper (2013) showed that pulled spinoffs (where workers in the new company were previously employed in the parent company) had higher survival rates than pushed spinoffs (where the parent company went out of business within one year of starting the spinoff) and residual categories of firms (2–10 employees with no relation to parent companies or where employees were unemployed before the start-up). While the latter two categories had the lowest survival rates, they had the highest number of entries – suggesting that a large number of entrepreneurs enters the Swedish market, but lacks prior knowledge of the business domain. Taken together, relatedness to parent institutions and...
proximity of knowledge bases seem to influence start-ups (cf. Nooteboom, 2000) as well as survival rates.

Despite predictable patterns regarding start-ups and survival rates, other data suggest that entrepreneurship is an activity that is inherently difficult to plan for. Furthermore, although planning has been found to improve the survival rate of entrepreneurial ventures, planning as an activity is questioned (Brinckmann et al., 2010). Consistent with this, Cassar (2010) found that business start-ups that have gone through a formal planning process had the least realistic forecasts. Similarly, a recent study following 623 nascent entrepreneurs during a six-year period adds no evidence that planning activities supported development of firm (Honig and Samuelsson, 2012).

The social level

Peer effects, such as university networks (Kacperczyk, 2013), having an entrepreneur in the family (cf. Greve and Salaff, 2003) or in one’s close social network are good estimators of future entrepreneurship (Giannetti and Simonov, 2009). Thus entrepreneurial role models may not only facilitate learning of entrepreneurial skills; they may also reflect positive images that enable support from both formal and informal institutions (cf. Shapero and Sokol, 1982; Baumol, 1990; Aldrich, 1999; Arenius and Minniti, 2005), as well as being the mental representations against which nascent entrepreneurs measure themselves. Yet such peer effects may also be social pressures that restrain entrepreneurship. Nascent entrepreneurs are likely to have their base of contacts in the region where they live and this gives them reasons for setting up their business there (Cooper and Folta, 2000; Sorenson, 2003; Stam, 2007; Parwada, 2008). A significantly higher number of entrepreneurs work near their birthplace in comparison with the fraction of dependent workers (Michelacci and Silva, 2007). Being close to family and friends may be helpful, not necessarily in aiding with the venture, but for emotional reasons (Dahl and Sorenson, 2009). They may have the opportunity to view the start-up as a real option strategy by starting on a part-time basis (cf. Wennberg et al., 2007) as a potential spouse can keep a job, granting at least one income (Hanson, 2003). Attentional capacities of the entrepreneur can then be devoted solely to the start-up. However, strong social ties may also filter information, preventing it from reaching the entrepreneur, which in turns renders cognitive lock-ins (Uzzi, 1997). Thus, while social bonds give access to specific information regarding local conditions, these bonds may also cause conformity to current practices.

In sum, entrepreneurship hinges on both individual characteristics and the contexts in which they are played out. On the one side, entrepreneurs
are considered as engines of economies, mainly by introducing variety that in turn causes spillover effects. They identify, translate and transform overseen opportunities, which others willingly or unwillingly have to react to. On the other side, entrepreneurs are described as conforming to social pressures, making entrepreneurship into a path-dependent process (for a comprehensive review see Staber, 2005). Thus the tension between characteristics and context not only focuses on which of the two forces is the most influential in order to produce successful entrepreneurship, but also on the consequences of the recursive links between the two. In other words, while the context may either restrain or highlight certain characteristics, in turn, certain characteristics may work in favor of changing the context. Such evolutionary niches may over time relocate both individuals and resources, making a region more absorptive of a particular kind of characteristic. Moreover, in order to create successful entrepreneurship, such local evolution raises a concern about what are the optimal levels of both propensity and density of entrepreneurship. Thus, rather than that everybody should be an entrepreneur or that no one should be an entrepreneur, the distribution of entrepreneurs in a region comes to the fore. These matters will be addressed in more depth in the next section.

3. CONCLUDING DISCUSSION

So far, the chapter has emphasized how a micro-level factor, such as overconfidence, and different contextual pressures affect start-up and survival rates. To conclude and further elaborate on these matters, this section will synthesize the review by focusing on how these factors interplay.

Regional characteristics, such as the number of new businesses in the relevant regional market, regional employment growth and the size of the region, have a marked impact on survival rates (Falck, 2007). However, localized spatial conditions of ‘neighborhoods’, as small as 1 km², that are dense with entrepreneurs are also likely to provide a climate where knowledge spillovers more easily happen (Andersson and Larsson, 2013). Thus attention should be directed to mechanisms that are set off at the local level, but may transfer across levels, especially since individual level behavior seems to multiply in social interaction, making it difficult to draw conclusions about individuals based on aggregated data (Glaeser et al., 2003).

As the complexity of the business climate causes entrepreneurs to be ‘boundedly rational’ (cf. Simon, 1957; March, 1994), it also amplifies the risk of systematic cognitive errors in reasoning. In the case of overconfidence, entrepreneurs may be aware of market conditions (such as failure
rates), yet decide to enter due to assigning inaccurate weight to the probability of their own success. Overconfident individuals are likely to have an impact mainly at the local level, as it is in social interaction that overconfidence will be communicated. From the review we know that overconfident individuals are more likely to start up businesses (Kahneman and Lovallo, 1993; Arabsheibani et al., 2000) as well as that overconfidence contributes negatively to survival rates (Hmielski and Baron, 2009; Gudmundson and Lechner, 2013). We also know that entrepreneurs conform to and benefit from local pressures by being more likely to set up their business in the region where they live (cf. Cooper and Folta, 2000; Sorenson, 2003; Stam, 2007; Parwada, 2008). These areas are constituted by different networks, being relatively homogeneous as their make-up is cognitively related (cf. Neffke et al., 2011; Boschma, 2008), which in turn is likely to provide similar structures of norms. In turn, even though trust may be high within such networks and facilitate knowledge exchanges, such conditions may also restrict individuals from acquiring viable business information (Uzzi, 1997) that otherwise would have caused them to reconsider a specific decision. Thus the conditions for such homogeneous regions may not be optimal for entrepreneurship. Overconfident individuals, belonging either to the network or coming from the outside, are more likely to set up their business as their ‘inner view’ suggests that they will be more likely to succeed than others regardless of external pressures. In other words, their optimistic, shallow and miscalibrated processing of prevailing probabilities of start-ups and survival rates causes them to enter. The lack of systematic processing, distrust and little consideration of disconfirming information influences survival rates at later stages of the business process (cf. Uzzi, 1997; Hmielski and Baron, 2009).

Thus overconfident entrepreneurs are relatively insensitive to information coming from the community they are entering and therefore are also unlikely to conform to prevailing norms. In fact, overconfident individuals tend to be more overconfident the more experience they accumulate (Gervais and Odean, 2001). However, in order to set up their business, they still need to communicate with parties in the community. This causes them to relate to members of the community, but through disclosure of personal information, as it is their inner view that is communicated, rather than information that harmonizes with community or current statistical base rates. In evolutionary terms, the miscalibrated judgment that gives rise to start-ups also provides a secondary effect in that it beacons personal information. Regardless of the accuracy of such information, the community will need to react to it – either by embracing it or by disregarding it. Thus overconfident individuals also contribute to the introduction of a (related) variety into a community (cf. Nooteboom, 2000). Since
overconfident entrepreneurs by definition are miscalibrated, some ideas will show a better fit to the market than others. In other words, the most overconfident will not only be fast movers, but also be the most miscalibrated, which will lead to the fastest exit/death.

It has been troublesome to find a distribution of entrepreneurship that optimizes economic growth (cf. Audretsch and Keilbach, 2005; Kelley et al., 2011). Focusing on overconfidence as an evolutionary mechanism is likely to give a curvilinear distribution of entrepreneurs within a community. A community without a significant number of entrepreneurs will remain homogeneous and eventually wither as there will be less variety and thus fewer changes setting off spillover effects. Competition will lead workers to move within already existing companies, causing the bulk of companies to grow even more homogeneous. A community where entrepreneurs constitute a growing number of members, approaching the peak of the curve, will mean that variety is introduced in order to both sustain and develop new businesses. A community where overconfident entrepreneurs have increased the distribution of entrepreneurs will eventually become saturated. Too large a proportion of entrepreneurs gives rise to too much novelty and experimenting and will therefore be an uncertain approach. The absorptive capacity (cf. Cohen and Levinthal, 1990) must be adequate; too large a distribution of entrepreneurs would mean too fragmented a knowledge base, especially as overconfident entrepreneurs would be less likely to benefit from any variety introduced because of their predisposition to stay committed to their own idea. On the positive side, though, it is reasonable to assume that, during progress towards saturation such local levels as neighborhoods become evolutionary niches (cf. Lewontin, 1982, 2000; Odling-Smee, 1988). Not only would the density of (biased) entrepreneurs increase, but the neighborhood would also experience non-market effects of shared norms and rules that in turn affect interpretation, for instance rules, regulations and routines. Such niches would work in favor of increased entrepreneurship, at least temporarily. The role of these changing conditions would also contribute to establishing positive representations of entrepreneurs. Since networks are ‘leaky’, these representations would not only be communicated within, but also between, networks. Thus the role models would come to represent not only positive images of entrepreneurs, but also a community of entrepreneurial opportunities. Such representations would be especially likely to attract nascent and biased entrepreneurs as these would be more responsive to discrete images of risk (i.e. role models; cf. Pham, 2007; Kahneman et al., 1999) than to an ‘outside view’ (Kahneman and Lovallo, 1993) that incorporates an actual evaluation of risk probabilities. Thus cognitive biases would become a reinforcing mechanism that facilitates start-ups,
but in the long run hinders survival of firms due to shallow processing capabilities and saturation of entrepreneurs.

In sum, one can conclude from this chapter that overconfidence can be detrimental for the single individual as it contributes to both excess entry and lack of survival. Yet, on more aggregated levels of analysis it may actually, up to a certain degree, benefit the system. From an evolutionary point of view a high number of entrants is desirable. As high entry rates are seen to introduce variety in terms of new knowledge that incumbent firms must reject, adapt or react to, high entry rates facilitate economic development along certain trajectories. High numbers of exits are less of a problem as long the number of entries is high, but the closer to the status quo (the ratio between entry and exits) it gets, the slower the development. The problem would be more difficult if the large number of exits caused nascent entrepreneurs to refrain from entering. Then, given that entries bring in new knowledge, a low number of entries would make the knowledge stock more homogeneous and thereby hinder economic development. Thus this chapter posits that high entry and exit rates are problematic at localized levels or for the agents themselves, but not to the system as a whole. In turn, such claims lead to discussions of both implications for research and implicit utilitarian assumptions in policies – who should benefit, the individual or the system?

3.1 What, Whom and How to Research

Theoretical and research-based implications

In terms of research, there are several avenues along which to proceed. First, the basis of evolutionary studies implies an emphasis on development over time. For instance, enacted overconfidence at later stages of the evolutionary process will have a different outcome than it has if enacted early in the process. Thus there is a need for studies emphasizing life-cycle approaches rather than focusing on how single variables condition single outcomes.

Second, the level of analysis is crucial in order to understand both economic development in general and entrepreneurship in particular. While, for instance, economic geography has used firms as the main unit of analysis (cf. Boschma, 2004; Frenken and Boschma 2007), studies in entrepreneurship have emphasized the individual. The benefit of firm formation and self-employment ratios as entrepreneurship proxies are indeed beneficial in creating a rational basis for entry decisions. Yet it is less informative about the specifics that underpin motivations or cognitive distortions in entrepreneurship. Increasing knowledge about the latter is particularly important, for the reasons mentioned above (Glaeser et al., 2003).
Third, available statistics most often lack data needed to draw adequate comparisons and conclusions. When researchers one-sidedly identify realized units (cf. Manski, 2003) such as start-ups, rather than nascent entrepreneurs who decide not to go into business, it causes sampling problems. Such sampling problems are crucial to studies of overconfidence as individuals would constitute a relatively larger part of those who both entered and failed in a distribution that in reality also emphasizes underconfident individuals (cf. Hogarth and Karelaia, 2012). From the review, it becomes clear that start-ups and survival rates hinge on assumptions found at both levels of analysis. In turn, such multiplicity is best addressed by mixed methods involving both quantitative analysis aiming for generalization and qualitative analysis, sensitized specifically to capture contextual aspects.

What a model depicts also tends to be less complex than how reality is constructed. A single bias, such as overconfidence, may positively influence start-ups and survival negatively, but, given the range of identified biases, there may also be other biases of interest. These may influence start-ups negatively, but survival positively, or influence both start-ups and survival positively. In this vein, Gudmundson and Lechner (2013) emphasized the cognitive make-up of entrepreneurs in terms of how it contributed to both organization and survival, showing that overconfidence was the primary negative influence on survival, while distrust enhanced survival.

There may also be other individual multipliers. Different personality traits (such as extraversion) may in turn cluster with biases. An extraverted overconfident entrepreneur who makes an entry, as opposed to an introverted one, would be more likely to communicate during the set-up of the business and thus produce early spillovers, thereby increasing the chance of survival of both his/her own and others’ business. However, overall few studies have emphasized composites of biases throughout the business process, making the clustering and indexation of different biases and other psychologically related concepts a much-appreciated contribution.

Practical implications
Given the literature and discussion, it seems that focusing on clustering of bias as well as perceptual variables would be a potential course to pursue. Considering that biases are most likely to arise in situations characterized by uncertainty, this also raises the question regarding whether there are specific sectors or industries that would be likely to be more biased than others. For instance, even though all firm formations involve some uncertainty, established and large-scale industries have developed routines and thresholds for entry, while small-scale innovation-laden industries
suffer from a lack of established routines and benchmarks. Thus querying whether biases would be more likely in Schumpeter Mark I as opposed to Mark II industries would be an interesting question to pursue.

The role of policies in these matters is difficult, as the chapter is based on a relatively small sample of empirical studies that address overconfidence. First, the micro-level point of departure in this chapter, taken together with the somewhat unpredictable outcomes of social interaction, implies that efforts need most of all to be directed to the micro-level. From a survival perspective, one may question why government funds or venture capital should be used to support non-spinoff start-ups, given the high failure rate. Furthermore, even if the help is both highly subsidized and accessible, the help seekers are asymmetrical in their approach to forming the start-up, with inexperienced nascent entrepreneurs being less likely to seek assistance (Brixy et al., 2013). Nascent entrepreneurs that are biased are likely to overlook or even disregard information even if it is readily presented to them. This is a condition that makes them less likely to make sound judgments at initial stages of the entrepreneurial process, but also one that makes them unlikely to learn from reactions of others who are at later stages of the business cycle.

Making nascent or re-entering entrepreneurs aware of risks of failure is difficult, as perceptions of risk are bound to the agents in rather deterministic ways. Neither biases nor perceptions of risk seem to be changed very easily because they depend on both the context and inherent human reasoning. One possible way to achieve change is to represent risk for nascent or re-entering entrepreneurs in ways that better harmonize with human reasoning and dynamic conditions of the environment. Given the range of accessible data resources and technical development in terms of ICT, life cycles of various sectors could be visualized instead of presented in tabulated form. Such an initiative would enable agents to perceive probabilities of risks as they would be represented visually rather than numerically. In turn, and in relation to virtual aids, bulletin boards, chat rooms and social media offer unprecedented ways to organize, personalize and maximize information in a way that will contribute to diversity and thereby accomplish an outside view among both nascent and already existing entrepreneurs.

As mentioned previously, from an evolutionary point of view, the number of entries and exits is relatively unproblematic, unless exits become relatively larger. Thus policies should not only address and promote entries, but rather address safety nets for spinoff start-ups and spinoffs that have previously failed, but wish to re-enter. Furthermore, given that the factors causing entrepreneurs to go into business do not make them viable, other efforts could be directed to developing hiring
policies – to be able to deal better with requirements associated with later phases of entrepreneurship.

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When being wrong might be right


11. Manufacturing renaissance: return of manufacturing to western countries

Sam Tavassoli, Babak Kianian and Tobias C. Larsson

1. INTRODUCTION

Twenty-one percent of North American manufacturers reported bringing production back into or closer to North America during the second quarter of 2011 (surveyed by manufacturing sourcing website MFG.com in June 2011). More than one-third of US-based manufacturing executives at companies with sales greater than $1 billion are planning to bring back production to the USA from China or are considering it (BCG, 2012). For example, General Electric (GE) recently announced a $1 billion investment to ‘re-shore’ the manufacturing of its appliances from Chinese plants back to a plant in Kentucky, USA (Crooks, 2012; The Economist, 2013). This is obviously a new trend (The Atlantic, 2012), because from the late 1960s to early 1970s up to recent years, the trend was actually the other way around, that is, western manufacturing had moved extensively to less developed countries (LDCs). As Norton and Rees (1979, p. 147) argued, the main reasons behind the original shift to LDCs were ‘the low labor cost and favorable business climates of such LDCs as South Korea and Taiwan’. Vernon (1979, p. 266) noted: ‘Although income, market size, and factor cost patterns have converged among the more industrialized countries, a wide gap still separates such countries from many developing [LDCs] areas’.

However, things have changed recently, and this rationale may no longer be true (at least not to the same extent as was the case in the late 1960s to early 1970s). Concerning labor cost, in a recent report Boston Consultancy Group anticipates that the net manufacturing costs in China and the US will converge in 2015 (Sirkin et al., 2011). Concerning business milieu, there have been recent and recurrent complaints about IPR (intellectual property rights) problems in China and other Asian emerging
economies. A new trend is now being observed that indicates the ‘return’ of manufacturing to western countries, especially to the US (Sirkin et al., 2011; The Economist, 2012; The Atlantic, 2012).

The aim of this chapter is to shed some light on this new pattern of a locational shift of western manufacturing, called in this chapter the ‘manufacturing renaissance’. This will be performed by developing arguments within the context of the PLC (product life cycle) model, while borrowing arguments from transaction cost theory and new economic geography.

The rest of the chapter is organized as follows. Section 2 presents the established PLC model briefly. Section 3 demonstrates the newly observed trend in the location of manufacturing. This is done by adding the additional phase to the established PLC model. Section 4 discusses the factors driving a new pattern. Section 5 summarizes and concludes.

### 2. PRODUCT LIFE CYCLE MODEL (PLC)

The PLC approach to international trade and investment provides a systematic explanation of how the location of manufacturing, exporting and importing of a product changes over time. Such locational shifts have been studied initially at an international level (Vernon, 1966, 1979; Hirsch, 1967; Wells, 1969). This was followed by studies of the PLC model at an interregional level (Rees, 1979; Norton and Rees, 1979).

Vernon’s (1966) original model proposes that the location of production and, subsequently, the export and import patterns, is varying based on the maturity level of the product. More specifically, Vernon (1966) argued that the production of a product in its first phase of development (i.e. new product phase) would be located in the US. First, this is because there is a higher demand for new products in the US market, among other things, because of high average income in the US in comparison with other countries (Vernon, 1979). Second, this is because there are more supplies of high-skilled labor (Hirsch, 1967) as well as externalities (that is, in terms of swift and effective communication between the producer, customers, suppliers and even competitors) available in the USA (Vernon, 1966). The two supply factors are essential for overcoming the uncertainty in product specification and market, which are inherently present during the early phase of product development (Utterback and Abernathy, 1975). This early phase of product development is associated with higher US exports.

The production of the second phase of product development (i.e. maturing product) would be located in other advanced countries. Vernon (1966) argued that, as the demand for a product expands, a certain degree of
standardization usually takes place; however, there is still the capacity for product differentiation. Since there are some degrees of standardization, there would be relatively less need for externalities. Instead, there would be more orientation toward economies of scale and more concerns about production cost rather than product characteristics. This is why the manufacturing location of a product would presumably move to other developed countries. Hence US-made production would stagnate and imports from other developed countries would start. However, the US balance of payments would still favor the US as exports dominate imports.

Finally, within the third phase of product development (that is, standardized product) production would probably move to less developed countries (LDCs), since they can provide competitive advantages for a production location. Vernon (1996) provides several reasons for such a claim. First, standardized products tend to have a lower uncertainty in terms of their specification (unlike new products). Hence the need for skilled labor and externalities (such as local knowledge) is remarkably reduced. This reduces the dependency of the producer on the US or other advanced countries. Second, standardized products tend to have a lower uncertainty in terms of the market; that is, they have a well-articulated and easily accessible international market, so the marketing costs (from a distance) are low. Third, these products are assumed to have high price elasticity of demand, unlike new products, and they are assumed to be mostly sold based on price. This would act as a motivation to take the risk of moving production to a new location. Fourth, these products need significant labor inputs for their production, which is again an incentive for moving production to low-cost labor countries, that is, LDCs. As a consequence, it may be wise for international firms to shift the location of their standardized products to the LDCs, conditional on the fact that labor cost differences are large enough to offset transportation costs. This would be associated with higher imports and lower exports for the US.

It should, however, be noted that the PLC model has received critiques, including criticism of the assumption of strict standardization of products in this third phase. Arguing that not all products can be strictly standardized challenges such assumptions. For instance, high-tech products with remarkably short life cycles may never reach the standardization phase. This is particularly the case considering the fact that contemporary industrialized countries are currently in the knowledge economy era, where the need for tacit knowledge (accessible in the home country) may never vanish completely (Acs et al., 2002). Therefore it is not reasonable to assume all products enter the third phase of the PLC model.
3. MANUFACTURING RENAISSANCE: A NEW PATTERN

The authors’ contribution to the established model of PLC developed by Vernon (1966, 1979) and Hirsch (1967) is a fourth phase called ‘manufacturing renaissance’. This is not the first time a study has tried to modify the original PLC model based on the observed trend (see Vernon, 1979; Giddy, 1978). The main argument for introducing this fourth phase here is two-fold. First, it deals with recent structural changes in emerging economies as well as in western countries (production-based argument). Second, it deals with characteristics of products and what has happened concerning the demand for new products (innovation) in western economies (product-based argument). Moreover, the impacts of such changes on the behavior of the US and other advanced economies are difficult to distinguish, since these two groups have become homogeneous in terms of various externalities over time (Vernon, 1979). The new pattern of production location, import and export for three classic categories of countries is depicted in Figure 11.1.

Assuming that the proposed theoretical PLC model correctly reflects reality, the first three phases of Figure 11.1 are identical to the original PLC model proposed by Vernon (1966), while the fourth phase is an add-on.3 The main idea of adding the fourth phase is that the manufacturing sector is growing again in western countries. This can occur through three channels. First, it is due to the newly observed phenomenon of ‘re-shoring’. According to Gray et al. (2013, p. 29), ‘a firm cannot pursue re-shoring unless it had previously pursued offshoring’, hence re-shoring should bring back jobs to western countries from LDCs.4 Through the re-shoring channel, either a product within the standardized phase may enter into a fourth phase of the PLC model or a new product can be substituted for the old one in a similar fourth phase. The former case happens in the ‘production phase’ of a product’s manufacturing cycle. The latter case happens in the ‘product development phase’ (product idea, product design and prototyping processes). Second, it could be through initiation of new manufacturing in western countries that has never taken place in LDCs. This is part of the manufacturing renaissance because this manufacturing could have been initiated in LDCs, but they ‘choose’ to locate in western countries. These products are most probably related to emerging technologies, like biotech- or nanotech-related products. Third, an increase of manufacturing within western countries could be due to the increase of FDI (foreign direct investments) in manufacturing sectors. This seems to be the case, as a recent report, the Survey of Current Business, shows that FDI in the US has doubled from 2000 to 2011. Manufacturing is also the
Note: Vertical axes are volume of output and horizontal ones are time. The first three phases are based on the original PLC model by Vernon (1966). The fourth phase (manufacturing renaissance) is the add-on of the authors, based on arguments throughout the chapter, specifically in Sections 3 and 4.

Figure 11.1 Extended product life cycle model
number one sector contributing to such doubling (Lowe, 2012). In this chapter we focus mostly on the first two channels. Such new patterns of the manufacturing renaissance in western countries can be explained by several driving factors, which are discussed in Section 4.

4. FACTORS EXPLAINING THE ‘MANUFACTURING RENAISSANCE’

There may be several factors driving the new locational pattern of modern manufacturing, that is, the manufacturing renaissance. The authors propose these factors to be: increasing wage-levels in emerging economies; the current lower quality of the business milieu in emerging economies (LDCs); new sources of economies of scale within western countries; and motives for bringing manufacturing closer to the customers’ demands in western countries. The first three factors refer to the supply side of this transaction, while the latter focuses on the demand side. Moreover, the first three factors are more production (structural) arguments, while the last factor is related to the product itself. A discussion of each factor is presented in the following subsections.

4.1 Rising Wage Levels in Emerging Economies

Wage levels have always been an important motive for offshoring manufacturing to LDCs (Norton and Rees, 1979; Vernon, 1979), especially if economies of scale are already being fully exploited (Vernon, 1966). Recent evidence also suggests that the wage differential is still one of the most important drivers of offshoring to LDCs. In examining the motives for offshoring, a recent survey finds that more than 50 percent of firms in Denmark, Sweden and the Netherlands state that labor cost savings are the primary reason for offshoring their business functions abroad (Statistic Denmark, 2008). Moving to LDCs has been mainly faster for labor-intensive industries, due to the increases in industrialized countries’ wages relative to the rest of the manufacturing sectors (Puga and Venables, 1996). In addition, weakly linked industries are also the ones which moved faster to LDCs, because they benefit less from being close to other industries in the western world. They neither sell a large fraction of their output to other industries nor spend a large share of their costs on intermediates produced by them. They are therefore the first to re-shore in response to labor cost differentials, being gradually followed by more capital-intensive and strongly linked industries (Puga and Venables, 1996).

However, a new report cites that the original labor differential which has
enabled companies to move to LDCs since the 1970s is no longer present to the same extent. For instance, Boston Consultancy Group argues that the wage level in China is increasing by an average of 20 percent annually and productivity improvement is not enough to offset the labor cost. On the other hand, it is known that the average US wage level has stagnated for the past couple of years. Even some new reports show a decline in US wages in manufacturing by 2.2 percent after 2005 (The Economist, 2013). Such a decline in US wages is mostly in southern states and is mainly due to the financial crisis, which increased the unemployment rate, and eventually increased the willingness of the labor force to work for lower payment. Hence, it is anticipated that net manufacturing costs in the US and China will converge in 2015 for many industries, including computer and electronics, appliances, furniture, and machinery (Sirkin et al., 2011). Such a new situation definitely contradicts the traditional main driver of moving manufacturing to LDCs, that is, wage-level differentials. Recent evidence suggests that heightened wages in some LDCs has reduced US offshoring to those countries (Swenson, 2005). However, it should be noted that the rising wage levels in China may lead to lower offshoring of western manufacturing to China, but this does not necessarily imply that this will lead to increases in manufacturing in the west. Instead, higher wage levels in China may lead to offshoring of western manufacturing to other LDCs, like Cambodia or Mexico. This could be especially the case for capital-intensive and low-skilled products that have longer life cycles.

One may ask why the wage level in emerging economies (especially China) has been increasing dramatically in recent years. There may be at least two reasons for this. First, as Puga and Venables (1996) argued, offshoring of manufacturing to a country will eventually lead to growth of that industry in that country. This implies a growth of demand in manufacturing within that country. Finally, this leads to bidding up wages in that industry and country, and eventually a point of critical mass will be reached. At this point, it is no longer profitable to stay in the previous country; hence manufacturing will move to another country. This is actually what happened in LDCs, particularly in China. Second, there has been a new trend of ‘brain circulation’, that is, a return of highly educated Chinese (and those of some other LDCs) from the USA back to their home country (Saxenian, 2006). These people usually have a higher salary than ordinary employees in LDCs. Therefore, by returning to China, they have raised average wages.

Furthermore, even if (part of) manufacturing returns to the west, this may not be an equilibrium state in the long run, and manufacturing may come back again to emerging economies in the future. This can be explained by two reasons. First, as Puga and Venables (1996) argued, the
return of manufacturing to the west will eventually lead to further growth of that industry in western countries, implying further growth of demand in manufacturing in those western countries. Finally, this leads to further bidding up of wages in that industry and country, and another point of critical mass will eventually be reached. Second, and from a demand perspective, if emerging economies grow fast enough and thus demand increases in these locations, then there will again be an incentive to move manufacturing back to the emerging economies in order to be at the center of demand (Gray et al., 2013).

4.2 Falling Quality of the ‘Business Milieu’ in Emerging Economies

It is shown that entry to new markets involves transaction costs, which are reduced via a proper institutional setting of the host country (Meyer, 2001). A proper institutional setting (business milieu) was indeed one of the reasons why manufacturing moved wholesale to less developed countries (LDCs) in the late 1960s and early 1970s (Norton and Rees, 1979; Vernon, 1979). Recent studies also emphasize the importance of government trade policies (a form of business milieu) as an important factor in attracting manufacturing into a particular region (Ellram et al., 2013).

However, it seems that the business milieu in emerging economies is not as favorable as before. First, recently there have been recurrent complaints about IPR issues in China and other Asian emerging economies. It is argued that China’s enforcement of its IP laws has been inadequate (e.g. lack of action against counterfeiting and piracy), although the framework of IP protection has been well established (Wang, 2004). Second, strikes are becoming more frequent in plants in LDCs, which makes companies lose profits. For example, this made Honda (a Japanese car maker) give its Chinese workers a 47 percent wage rise after their strike in 2010. Similarly Foxconn (a Taiwanese firm that does much of Apple’s manufacturing in China) doubled its wages in Shenzen, China after a series of suicides that happened at its production site (The Economist, 2013). Third, recent studies show that the current governance practice adopted in China is dominated by a control-based model,⁶ which contrasts markedly with the market-oriented model commonly used in western countries such as the USA and the UK (Liu, 2006). Given that the market-oriented governance model is recognized as the superior model (Bai et al., 2004), this simply means western companies aiming to operate in China may not expect to operate in better institutional conditions than those of their home countries. Fourth, because of the one-child policy in China, the latest generation of workers seems not to be as abundant as before. Moreover, this new generation seems to be less willing to spend long hours in boring facto-
ries, especially in foreign MNEs that require higher quality standards (and eventually more work for the worker) than domestic firms (The Economist, 2013). Fifth, a new labor law introduced in 2008 in China provides more protection for workers there, including the right for permanent employment after only a year of temporarily employment. On the other hand, the United Auto Workers Union (UAW), as one of the biggest unions in the USA, accepted a two-tier wage structure under which new blue-collar workers are paid only half as much as the longer-employed ones (The Economist, 2013). This obviously provides incentives for large American car MNEs to bring back at least some portion of their activities back home. All in all (the same argument as in 4.1), this means that China is now offering fewer advantages when it comes to labor-intensive industries. All of these four issues can disrupt the previous image about the proper business milieu in LDCs (Wang, 2004). The lower quality of the business milieu (especially the point about the IPR problem) can be understood via the concept of ‘opportunism’, which Williamson (1981) described as dishonest behavior by competing firms. According to transaction cost theory, opportunism represents a source of transaction costs. It is one of the determinants of whether firms will choose offshoring or vertical integration. Williamson (1981) argued that vertical integration arises out of the need to safeguard against opportunism and contractual hazards.

Furthermore, from supply chain management studies it has recently become evident that the original offshoring decision was usually based on a tempting per-unit price, with little consideration for total cost analysis, which includes hidden costs, such as midnight phone calls, delivery delays, IP leakages, communication challenges and travel (Moser, 2011; Gray et al., 2013). Such total cost consideration, on one hand, and boosting innovation in China (partly because of IP leakage and imitation), on the other, has been argued to be a threat to western innovation-based competitiveness (Wang, 2004). Therefore not only has the lower quality of the business milieu in China in recent years blurred one of the traditional motivations to move manufacturing to China, but also the imitation skills of Chinese companies can be a threat to the innovation-based competitiveness of western companies.

4.3 Emergence of New Process Innovations in Western Countries (as a New Source for Economies of Scale)

Economies of scale can reduce total production costs. They can be achieved, for example, through the presence of a large number of suppliers in a particular region (or country), hence reducing the average cost of production per unit (Teece, 1986). One of the traditional ways to
Innovation and entrepreneurship in the global economy

achieve economies of scale for western companies has been to move their manufacturing to China and other LDCs, to enjoy the presence of a large number of (cheap) suppliers in a particular region. This has been especially the case for those western companies that were followers (not first movers) in terms of offshoring manufacturing to China and other LDCs.

However, recent process innovations in western countries provide a new source of scale economies, which reduce reliance on the traditional source of scale economies (i.e. moving production to LDCs). As the magazine *The Economist* (2012) wrote recently:

> It [recent process innovations] will allow things to be made economically in much smaller numbers, more flexibly and with a much lower input of labor, thanks to new materials, completely new processes such as 3D printing, easy-to-use robots and new collaborative manufacturing services available online . . . And that in turn could bring some of the jobs back to rich countries that long ago lost them to the emerging world. (*The Economist*, 2012)

The main point here is that the cost of producing much smaller batches of a wider variety of products (with each product tailored precisely to each customer’s need) is indeed falling. The factory of the future seems to have a focus on mass-customization, rather than traditional mass-production. This means less reliance on economies of scale (available through extensive availability of cheap suppliers in China), which could eventually lead to the return of some manufacturing processes to western countries. This is indeed what Grossman and Helpman (2005, p. 159) argued: ‘disproportionate improvements in the technology for customization in a region can shift the manufacturing toward that region (here referring to the western countries, in particular US)’.

One prominent example of such ‘improvements in technology’ is additive manufacturing (AM) technology. This is a relatively new manufacturing method (process innovation) that first came into use in the late 1980s.\(^7\) According to the CEO of Koenigsegg (a Swedish hyper-car company), AM technology is useful for both (i) prototyping (faster, less waste, and allows for extremely complex designs with no limitations) and for (ii) final products, especially in low volume (e.g. hyper-car components), due to the lower cost of production compared with casting techniques (Kristiansson, 2014). The better the quality of AM fabricated products, the less need for (unskilled) labor, and hence lower labor costs. This will create a scenario where manufacturers in regions with relatively higher labor costs will be able to compete with those with lower wages in LDCs. This is because AM technology (as a process innovation) provides a major gain in productivity, which in turn drives down the production cost and can hence offsets the LDCs’ wage/cost advantages (Bonvillian, 2012). In addition,
combining this competitive pricing with the concept of quicker delivery to customers will provide local suppliers with an advantage over their foreign competitors (Wohlers, 2011).

Moreover, the rising cost of energy and its efficiency are major barriers to the future of manufacturing and play a significant role in shaping the geography of production. One major cost of energy is associated with waste. AM processes are proven to produce significantly lower waste compared to conventional methods (Wohlers, 2011). Another major source of overall energy costs is that of transportation. Much more energy is needed to ship and deliver parts from a long distance than to do so from a local or regional retailer and supplier. Studies indicate that due to problems such as communication and tool rework and transportation costs, the actual costs of offshore manufacturing can in many cases be higher than anticipated and believed (Wohlers, 2011). To sum up, the emergence of new process innovations (such as AM technologies) makes it possible to locate manufacturing in relatively high-labor-cost regions, because of the productivity gains that new process innovation can offer. Moreover, the ability of AM technologies (as a new process innovation) to meet the new trend toward mass-customized production (for both final products and prototypes) makes it an attractive option for western companies. Here, AM technologies can be a channel to bring back old products (that were once offshored to LDCs), but most importantly can be used in the product development stage (design and prototyping) and hence contribute to new products in the fourth phase of the PLC. In either case, it is expected that AM technologies will bring back somewhat different types of jobs to western countries (not exactly the same ones as found in LDCs now). A prominent example is the multiplier effects generated through this channel, which can boost service-provider jobs around manufacturing jobs (Bonvillian, 2012). Moreover, since the type of jobs returning is different, there is a need for different skills. This implies increased need for high-skilled labor to operate with advanced machinery such as 3D printers.

4.4 Rising Demand for Western-made Manufacturing

Apart from the supply side, recent studies show that demand for US-made products is already in the place. A survey by Boston Consulting Group (BCG) in September 2012 of 5000 consumers in several countries shows that more than 80 percent of US consumers and, perhaps more surprisingly, over 60 percent of Chinese consumers prefer to pay more for products labeled ‘Made in USA’ than for those labeled ‘Made in China’. This result clearly creates incentives for US companies to bring back some parts
of their manufacturing. In addition to such demand incentives, there are other incentives concerning better interaction with home customers. The PLC model argued that manufacturing production would be offshored to LDCs in the third phase, assuming strict standardization of products and lack of need for customer interaction. This is, however, a strong assumption, especially if one considers the faster life cycle of technology in recent years within the context of the knowledge economy. A faster life cycle would require close interaction with home customers, even if a product reaches some degree of standardization. Being close to home customers would facilitate communication with consumers (and specialized suppliers) (Wells, 1969). This eventually implies that ‘market-determined inducement’ would ease incremental innovation for even somewhat standardized products (Dosi, 1988). This is especially true for those manufacturing sectors in which the distinction between the product development phase (R&D and design) and the production phase is blurred (Bonvillian, 2012). These are the manufacturing sectors that require a strict connection between research, design and production, for instance aerospace products, complex pharmaceuticals and energy equipment. Gereffi et al. (2005) considered the type of governance of the global supply chain suitable for such a situation as ‘hierarchy’ (i.e. keeping production in house), in which complexity of transactions is high, while ability to codify transactions as well as the capability of suppliers abroad is low. In such a situation, it is preferable to keep production in house, rather than offshoring or outsourcing it.

Apart from facilitating incremental innovation, proximity to customers would mean better service to them, leading to higher customer satisfaction (Dunning, 1980). As suggested above, manufacturing has been offshored to LDCs basically because of cost-saving forces (Vernon, 1979). Now that those forces are not in play as strongly as before, it is reasonable to believe that some part of manufacturing will come back to the USA, to meet customer demand for US-made brands and also to have better interaction with home customers, inter alia. This is indeed acknowledged in recent studies suggesting a shift from resource seeking (e.g. low-cost host countries) to strategic asset seeking (e.g. better access to home market and customer satisfaction) (Cantwell, 2009; Ellram et al., 2013).

5. EXTENDED PLC MODEL

Following the above reasoning (Sections 4.1–4.4) on the occurrence of the manufacturing renaissance, that is, the fourth phase of the PLC model, it is possible to illustrate the characteristics of each stage of the model (see Table 11.1).
### Table 11.1 Characteristics of the product life cycles

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>New product</th>
<th>Maturing product</th>
<th>Standardized product</th>
<th>Renaissance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Short-run and rapidly changing</td>
<td>Mass-production and importance of economies of scale</td>
<td>Long-run and stable process</td>
<td>Mass-customization</td>
</tr>
<tr>
<td>Physical capital</td>
<td>Low</td>
<td>High, due to high obsolete rate</td>
<td>High, due to large quantity of specialized equipment</td>
<td>High, due to acquisition of new process innovations (such as 3D printers and robots)</td>
</tr>
<tr>
<td>Industry structure</td>
<td>Entry is know-how, many firms</td>
<td>Growing number of firms</td>
<td>Stagnation in number of firms</td>
<td>Growing number of spin-offs</td>
</tr>
<tr>
<td>Human capital</td>
<td>Scientific and engineering</td>
<td>Management</td>
<td>Unskilled</td>
<td>Scientific and engineering</td>
</tr>
<tr>
<td>Demand structure</td>
<td>Sellers’ market, low price elasticity of demand</td>
<td>Growing price elasticity of demand</td>
<td>Buyers’ market, high price elasticity of demand</td>
<td>Closer to customer, shorter technology cycles, medium price elasticity of demand</td>
</tr>
</tbody>
</table>

*Source:* New, maturing and standardized product characteristics based on Hirsch (1967). Renaissance is authors’ elaboration.
In terms of technology, as discussed in Section 4.3, short and rapidly changing technology in the new product phase was substituted by mass-production in the mature and standardized phases. Then, in the renaissance phase, the focus is shifted to mass-customization. This has been demanded by the market for several years, but has been possible to implement only recently by means of new process innovations, such as additive manufacturing (e.g. 3D printing) or robots (Harris, 2014). Such mass-customization may best be performed in western countries, mostly because of the need to be close to pioneering customers. Moreover, mass-customization always has some elements of ‘tailor-made to each individual customer’ (to varying degrees), in contrast to ‘standardization’. This is indeed one of the reasons that we think it is necessary to add the fourth phase to the original PLC.

In terms of physical capital, low need gradually shifts to high need as the product matures from the first phase up to the third phase. In the fourth phase, the need for physical capital can be seen in two ways. On the one hand, there is less need for physical capital (especially for low-volume production) because there is less need for expensive traditional manufacturing technologies such as injection molding and casting techniques. On the other hand, the new process innovations that are behind the fourth phase are relatively expensive to acquire, for example 3D printers or robots (Brynjolfsson and McAfee, 2011; Markoff, 2012). This is why it seems once again that there is a need for a high level of physical capital in the fourth phase.

In terms of industry structure, there are low barriers to entry in the early phase of product development, basically because the dominant design is not yet achieved and it is easier for many firms to enter the industry performing trial-and-error experiments to reach the dominant design (Utterback and Abernathy, 1975). This is indeed characterized as Schumpeter Mark I in the technological regime literature, where there are higher technological opportunity conditions to innovate and lower barriers to innovative entry in early phases of development (Malerba and Orsenigo, 1997). Then, as the product matures and a dominant design is achieved, there will be less entry, and the industry will then be characterized by a few giant actors (Utterback and Abernathy, 1975). This is characterized as Schumpeter Mark II in the technological regime literature, where there are lower technological opportunity conditions to innovate and higher barriers to innovative entry (Malerba and Orsenigo, 1997). In the renaissance phase, it is expected to see new entries, especially in the form of spin-offs. This is because spin-offs can be created that aim to satisfy the tailored need of customers in the form of mass-customization.
Hence it is expected that the renaissance phase may show similar characteristics as the first phase in terms of industry structure.

In terms of human capital, in the first phase, it is necessary to have more scientific and engineering skills (skilled labor) in order to overcome the uncertainty of the product and the market. There will be less need for skilled labor in the later phases as products become standardized. In the renaissance phase, there would be (once again, as in the first phase) the need for high-skilled labor for two reasons. First, high-skilled labor is needed to operate with advanced production machinery such as 3D printers. This is basically because the types of job that are returning to western countries are different from the types of job that are currently in LDCS (moving from the third phase to the fourth phase of the PLC). Second, as discussed in Section 4.4, the life cycle of products (especially high-tech products) is much shorter now, and there is more need for incremental innovation within existing products in order to stay competitive in the market. In this situation, the fourth phase becomes similar to the first phase in terms of the need for skilled labor for fostering innovation.

Finally, in terms of demand structure, there is low price elasticity of demand in the early phase because of the innovative and exclusive nature of the new product (sellers’ market). This will be changed as the product becomes standardized (buyers’ market). In the renaissance phase, elasticity becomes medium, and it is crucial to be closer to the customer again, basically because of the shorter life cycle of technologies. Being close to pioneering customers implies moving manufacturing back to western countries, as argued by the PLC model.

Note that the return of manufacturing to the west should be kept in proportion to the amount of manufacturing activities that are still being offshored to LDCs. This is because most MNEs involved in recent re-shoring are bringing back only some of their production to the west, destined for western markets (The Economist, 2013). Moreover, for most MNEs, the amount of offshoring still outweighs the amount of re-shoring. For instance, Caterpillar recently announced the opening of a new factory in Texas, while at the same time it is expanding its R&D activities in China (The Economist, 2013). Similarly, Airbus announced recently that it will open its first US-based production plant in Alabama (a southern state), while expanding its production facilities in China (Airbus, 2013). This is because China still provides the world’s best supply chains of components as well as proper infrastructure for various industries. In addition, even if labor cost may not be an incentive to stay in China (as discussed in Section 4.1), companies still have at least two reasons to stay in LDCs: (i) they have already invested heavily to be there, and coming home has obvious removal costs; (ii) the USA is no longer the only huge market;
China itself has become a huge market and all the benefits of being close to the customer (discussed in Section 4.4) could apply to the Chinese market too (Sirkin et al., 2011). Nevertheless, the Asian chairman for McKinsey recently said: ‘the incremental decision to invest in new production capacity in China has become tricky’ (The Economist, 2013). However, the question of whether the manufacturing renaissance is still just a tiny start (which may go nowhere in future) or whether it is already part of an unstoppable structural development trend is difficult to answer in this chapter. The answer requires availability of reliable data. To the best of the authors’ knowledge, the only reliable data are on FDI (foreign direct investment) in the USA. A recent report of the Survey of Current Business shows that FDI in the USA doubled between 2000 and 2011, and that manufacturing is the number one sector contributing to such doubling (Lowe, 2012). Although the FDI data is about the investment of other countries in the USA (and not about US firms bringing back some jobs to the USA), they show the attractiveness of the USA as the destination for manufacturing, generally speaking, and it is one of the channels that leads to the manufacturing renaissance phase (discussed in Section 3). However, further availability of data on return of manufacturing (re-shoring) versus offshoring is needed in order to systematically analyze the trend.

6. CONCLUSION

The manufacturing renaissance, that is, the return of manufacturing to the west, has recently been observed as a new pattern emerging in western countries, especially in the USA. This can occur through three channels: (i) the newly observed phenomenon of ‘re-shoring’; (ii) initiation of new manufacturing activities in western countries that have never been in LDCs; and (iii) rising FDI in manufacturing sectors in western countries. More importantly, this chapter identified four main drivers of this new phenomenon: (i) rising wage levels in emerging economies; (ii) falling quality of the business milieu in emerging economies; (iii) emergence of new process innovations in western economies; and (iv) rising demand for western-made manufacturing. In doing so, the chapter contextualized itself within a well-established theory that explains the locational shift of manufacturing, that is, the product life cycle (PLC) model. Nevertheless, the return of manufacturing to the west should be kept in proportion, as most MNEs involved in recent re-shoring are bringing back only some of their production to the west, destined for western markets. From the western policy-maker perspective, it is still essential to provide more incentives for MNEs to bring back their production plants to the west, which
will eventually lead to creation of more jobs. The potential jobs created in this way may no longer be the same jobs, as the emergence of new process innovation (e.g. additive manufacturing and use of robots) requires skilled labor to work with; hence the need to increase the average skill level of Western workers.

It is expected that not all industries will come back to the Western world at the same pace. The return of manufacturing to the west should be more pronounced for labor-intensive industries and also those industries that are weakly linked with other industries through the supply chain in LDCs, especially bearing in mind the significant increase in wages levels in LDCs.

With the availability of more reliable data, we propose two future research areas: first, investigating the ‘size’ of this new trend; that is, are we observing a tiny trend or can the trend be seen as a structural change? Second, testing the significance and magnitude of the four factors that we propose in this chapter as positively influencing the manufacturing renaissance.

NOTES

1. For further evidences of recent re-shoring, see Appendix Table 11A.1.
2. One should be cautious when it comes to citing consultancy reports, generally speaking. Nevertheless, these reports currently provide more or less the only available figures on the topic of the manufacturing renaissance.
3. The authors choose to keep the original model despite its critics (with three phases of PLC) and add the fourth phase (that is, manufacturing renaissance). The rationale for this is that the x-axis represents ‘time’ and the previous three phases illustrate ‘history’ now; that is, what more or less actually happened in the past. This is why the authors are not willing to question it. Instead the authors add the fourth phase in order to update the PLC model and bring it into line with what is happening now in the discussion of location of manufacturing.
4. The type of job coming back to western economies may not be exactly the same as those that are located in LDCs. This issue will be discussed further in Section 4.3.
5. It should be noted that the location of production goes to LDCs if labor cost differences are large enough to offset transport costs (Vernon, 1966).
6. Control-based model of governance refers to a model in which controlling shareholders (in this case mostly the state) employ possible governance mechanisms to strictly control the listed firms, such as inadequate financial disclosure and concentrated ownership structure.
7. In general, AM technology forms 3D physical objects by solidifying the raw material layer upon layer. Originally, due to its limited capacity and low resolution, the method was used for prototyping and model making; hence the term rapid prototyping. It has since been gradually developed towards providing end-use parts or direct part production, referred to as rapid manufacturing (Tuck et al., 2008).
8. There may be two different mechanisms behind the answers given by US consumers and Chinese consumers. The US ones may be pro US-made not only for the sake of perceived better quality, but also for the sake of patriotism. On the other hand, Chinese consumers’ positive answer for US-made may be only for the sake of quality.
REFERENCES


APPENDIX

Table 11A.1 Selected recent re-shoring announcements

<table>
<thead>
<tr>
<th>Company</th>
<th>Announcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Electric</td>
<td>General Electric announced in early 2012 that it was opening a water heater plant at Appliance Park in Louisville, KY, the first new plant at the site in more than 50 years. Ultimately, GE plans to invest $800 million in Louisville, part of a $1 billion commitment to create 1300 new jobs in the USA by 2014. Many of those jobs are being shifted from plants in China.</td>
</tr>
<tr>
<td>Caterpillar</td>
<td>The heavy equipment manufacturer has picked a site near Athens, GA, for a plant that will build small tractors and excavators, investing $200 million to shift some production back from Japan.</td>
</tr>
<tr>
<td>NCR</td>
<td>NCR builds ATMs and self-service checkout systems at Columbus, GA, which was opened in late 2009, and it plans to add another 370 jobs there by 2014, building products that were formerly made at plants in Hungary, China and Brazil.</td>
</tr>
<tr>
<td>Coleman</td>
<td>Coleman, the iconic outdoor equipment maker, announced in 2012 that it is moving the production of its 16-quart plastic wheeled cooler from China to Wichita, KA.</td>
</tr>
<tr>
<td>Methanex</td>
<td>Methanex, a Canadian-based company, will relocate a methanol production plant from Chile to a 225-acre site in Geismar, LA. The $550 million project will give the company its first US-based methanol production facility in more than a decade.</td>
</tr>
<tr>
<td>Farouk Systems</td>
<td>Farouk Systems, a manufacturer of hair dryers, moved 1500 jobs from China back to the USA.</td>
</tr>
<tr>
<td>Chesapeake Bay</td>
<td>The company opened a US manufacturing operation in Maryland for its candles and home-fragrance products that had been made solely in Vietnam and China.</td>
</tr>
<tr>
<td>Candle</td>
<td>Horton Archery, an archery and crossbow manufacturer, expanded its domestic manufacturing facility and moved all its production from China to Kent, OH. ‘Being on site to answer the phone and hear feedback from the field was one thing that we felt couldn’t be done in China’, says CEO Gregg Ritz.</td>
</tr>
<tr>
<td>Watts Water Technologies</td>
<td>The company will make a multimillion-dollar investment in a 30,000-square-foot plant complex in Franklin, NH, which is estimated to bring about 100 manufacturing jobs back from China.</td>
</tr>
</tbody>
</table>

Source: Adapted from McMeekin and McMackin (2012).
12. Closing the gap: empirical evidence on firms’ innovation, productivity and exports

Viroj Jienwatcharamongkhol and Sam Tavassoli

1. INTRODUCTION

Exporters are known to be a selected group of productive firms. They can afford the associated upfront fixed costs of entering foreign markets. In other words, they succeed in crossing the ‘productivity threshold’ and ‘self-select’ into exporting (Bernard and Jensen, 1999; Bernard and Wagner, 1997; Delgado et al., 2002; Melitz, 2003). The ‘self-selection’ literature has been an important theoretical foundation for many recent empirical trade studies, mainly due to its prediction, which is in line with the observed data. Besides being more productive, exporters are a bigger minority among firms – a stylized fact that Eaton et al. (2004) observe for French manufacturing firms.¹ However, the literature is still in its development stage and the existing evidence often provides a mixed picture. For example, the direction of causation between productivity and exporting is still an unresolved debate. The self-selection literature often treats firms’ productivity as being assigned from a random draw; thus it is exogeneous to the firm and remains a ‘black box’ in the model. So the question is: where does the heterogeneity of firms’ productivity come from?

Several explanations attribute a gain in productivity to the firm’s innovation-related activities, the argument being that a firm decides to invest in R&D and related activities to improve its operations. The result of a successful investment in these activities is likely to increase productivity and firms’ performance. Ederington and McCalman’s (2008) dynamic model introduces the difference in adoption rates of new technologies (or innovation) as the primary source of productivity heterogeneity. Segerstrom and Stepanok (2011) model firms’ R&D as either traditional quality improvement activities or investments for becoming exporters. Similarly, if we look at another strand of literature, namely micro-studies
of innovation, we find that the main source of productivity heterogeneity is firms’ investments in R&D and other innovation activities that lead to innovation output of the firm. The production function framework, advocated by Griliches (2000), and recently the endogenous growth model (Aghion and Howitt, 1992; Romer, 1990) attribute productivity gain to the firm’s capital accumulation and technological change (or innovation). Although innovation is a possible answer to the question we posed above, studies that attempt to examine this are still rare.

This chapter investigates the source of firms’ productivity by examining the link from R&D investments and innovation output to firms’ productivity and export performance. In doing so, we aim to close the gap between the self-selection (productivity-exporting) and innovation-productivity literature. The empirical evidence in this chapter comes from the modified structural model that extends the framework by Crépon et al. (1998) and Lööf and Heshmati (2006). Empirically, we employ two waves of Sweden’s Community Innovation Survey (CIS) and complement this with detailed data on firm-level characteristics and exports. The structural setting gives us the flexibility to interact innovation, productivity and firms’ exports. Moreover, we can deal with several econometric issues, namely selectivity, simultaneity and endogeneity problems.

Because not all firms invest in R&D and other innovation activities, excluding the non-innovative firms from the estimation will give rise to the selectivity problem. While allowing the interaction between innovation, productivity and export performance, we can deal with the simultaneity issue, since it is argued that exporting can also raise a firm’s incentives to innovate (Long et al., 2011). The dynamic nature of the innovation process involves a lag time; thus disregarding it will result in endogeneity problems. We will discuss this in more detail later.

Our main contribution is twofold. First, this study is relevant to the debate on firms’ innovative activity by providing a detailed empirical analysis using comparable CIS data to support the argument. From a policy perspective, on the other hand, including the export equation in our extended structural model provides an insight into the internationalization of firms and how innovation policies might be able to increase the competitiveness of the economy.

The rest of this chapter is organized as follows: Section 2 provides a relevant theoretical framework. In Section 3, we introduce the structural model as an empirical strategy and discuss econometric issues. Section 4 presents the data and descriptive statistics. The results and discussion are in Section 5, and the last section concludes the chapter.
2. CONCEPTUAL FRAMEWORK

2.1 Productivity – Exporting

Not all firms engage in exporting activities. Eaton et al. (2004) find, that among French manufacturing firms, exporters are a minority that tends to be more productive and larger than nonexporters. One of the main export barriers is entry costs. These costs can be variable, with a standard ‘iceberg’ assumption (Bernard et al., 2003), or fixed (Melitz, 2003; Roberts and Tybout, 1997).

The variable costs are assumed to consist mainly of transportation and tariffs, in which they vary with amount of export shipment and distance to destination. The fixed costs are the initial costs that each firm invests to obtain a permit, establish a distribution network and various other transaction costs. During the latter half of the twentieth century, the variable costs have seen a decline due to advances in technology and trade liberalization. This implies the growing importance of informal trade barriers, which constitute the upfront fixed costs.

Ample empirical evidence connects exporters with higher productivity compared to nonexporters. Wagner’s (2007, p. 67) survey concludes that, among 54 studies covering 34 countries, ‘exporters are found to be more productive than nonexporters, and the more productive firms self-select into export markets’.

Among all firms, only those at the upper end of the productivity distribution can afford the costs of entering foreign markets. But the initial productivity of each firm and the productivity distribution are exogenously determined (Melitz, 2003) or depend only on the variation in firms’ efficiency (Bernard et al., 2003). The theories developed thereafter have largely neglected productivity, and thus the source of productivity gain has remained a ‘black box’ until recently.

There are attempts to formally model firms’ exports with endogenous productivity. Ederington and McCalman (2008) develop a dynamic model with endogenous firm-level productivity by adopting new technology to explain the heterogeneity in firms’ productivity. In this model, the difference across firms is the timing of adoption due to the high cost, albeit marginally decreasing, of early technology adoption.

Segerstrom and Stepanok (2011) propose a quality-ladders endogenous-growth model without Melitz-type assumptions that firms invest in R&D to introduce new varieties of products. Instead, they distinguish two types of R&D technologies: inventing a higher quality of existing products; and learning how to export. The latter involves an investment in terms of stochastic fixed market entry costs. Compared to Melitz (2003), the
Innovation and entrepreneurship in the global economy

productivity threshold does not exist in this setting and there is an overlap of the productivity distribution between exporters and nonexporters. The difference between this quality-ladders model and the model by Ederington and McCalman (2008) is that each product requires a different level of R&D. It is, therefore, more difficult to invest in R&D and learn how to export complex and highly advanced products. Restated, it is the difference in product quality versus the difference in timing of technology adoption.

Other recent theoretical papers have also introduced R&D and innovation to provide a structural link with firms’ decision to export. In this strand of literature, firms make a joint decision to export and invest in R&D, in which this investment raises firms’ productivity and affects exporting positively, while participation in the export market also raises the return to R&D investments. The evolution of firms’ productivity is characterized as a stochastic process. Starting from exogeneous productivity in Olley and Pakes (1996), there are extensions to allow the evolution of productivity endogeneously with R&D (Doraszelski and Jaumandreu, 2013), product and process innovations (Peters et al., 2013), and exporting (Aw et al., 2011; Maican et al., 2013). Using this framework, the empirical evidence confirms the significant role of R&D investments in the evolution of productivity dynamics and exports among Taiwanese firms (Aw et al., 2007; Aw et al., 2008; Aw et al., 2011).

2.2 Innovation – Productivity

The innovation effect on productivity is well documented empirically (see Cohen, 1995; Griliches, 2000 for some surveys), and several theoretical models have proposed that firms may invest in R&D to increase productivity before entering foreign markets.

The endogenous growth theory provides an early foundation that links economic output and innovation (Aghion et al., 1998; Howitt, 2000; Romer, 1990). In a similar view, firms’ accumulation of technological capabilities is considered as one of the key sources of productivity advantages (Castellani and Zanfei, 2007). Firms with better technologies can increase profit margin and reduce prices, thus increasing competitiveness (Cantwell, 1989, among others).

The change in work practice, choice of production inputs and better managerial ability are also argued to be important factors contributing to an improvement in firms’ productivity. Schmitz (2005) points out that firms are more likely to adopt a new technology and gain higher productivity in a competitive environment, such as international markets, than domestic firms. Castellani and Giovannetti (2010) find that productivity
differences (or *premia*) among Italian firms vanish when high-skilled knowledge-intensive workers and differing returns on capital and labor are accounted for.

Klette and Kortum (2004) develop a theoretical model to link firms’ heterogeneity, R&D and productivity based on several stylized facts from empirical studies on the subject. In this model, the heterogeneity of productivity is derived from a variation in the size of innovation steps. The model predicts that R&D intensity will be positively correlated with persistent differences in productivity across firms.

Accordingly, the empirical evidence is growing, using the knowledge-production framework in microlevel studies of innovation, and shows that innovation indeed leads to higher productivity within firms across countries (Hall and Mairesse, 2006). This knowledge-production framework argues that innovation itself should be treated as a process with input and output parts. The empirical evidence suggests that innovation input increases innovation output and eventually it is innovation output that increases productivity (Crépon et al., 1998). So we base our analysis on the distinction between innovation input and output, which is considered vital for empirical innovation studies.

There is a consensus in the literature that innovation input stimulates innovation output. This can be discussed by referring to a stream of literature on the ‘two faces of R&D’, which shows that not only R&D (or innovation input, in general) stimulates innovation output, but also R&D can facilitate the imitation of other discoveries by increasing absorptive capacity (Griffith et al., 2004). The first face of R&D is a somewhat older argument, dating back to at least the knowledge production function framework, which provides evidence that R&D investment stimulates introduction of various measures of innovation at the firm level (Griliches and Schmookler, 1963; Griliches, 1979, 1990). The second face of R&D is a more recent argument, which refers to positive effect of the absorptive capacity of a firm (or the knowledge capital of a firm) on its imitative capacity and eventually innovation (Cohen and Levinthal, 1990; Klette and Kortum, 2004). Quantitatively, innovation input has traditionally been measured as R&D investment (Griliches, 1998), but more recent innovation surveys have added more categories, such as investment in training of employees (OECD, 2005). This addition of more categories to innovation input is important, since, for instance, it is shown that R&D investment accounts for only about one quarter of the total innovation input expenditure in Dutch firms (Brouwer and Kleinknecht, 1997). In this chapter, we incorporate the term innovation input to encompass all the categories of innovation-related activities.

Innovation output has traditionally been measured in terms of patents.
Innovation and entrepreneurship in the global economy

or even productivity (Klette and Kortum, 2004), while recent innovation surveys, following Schumpeter (1934), have provided more direct measures of innovation output, grouped in several types: product, process, marketing and organizational innovation (OECD, 2005). In particular for product innovation, an attractive measure has been available – the amount of firms’ sales due to innovative products – which is argued to have fewer weaknesses compared to classic measures (Kleinknecht et al., 2002).

Using this quantitative measure of innovation output, we can plot in Figure 12.1 the distribution of productivity of all Swedish firms in this study. The thick solid line representing innovative firms is vertically above the dashed line of noninnovative firms at the upper end of the productivity distribution, to the right of the horizontal axis. This implies that, among all firms, innovative firms are those that appear more concentrated, that is, have a higher density, at the upper end of the productivity distribution.

From the discussion above, we can establish two hypotheses:

\[ H1: \] Export performance is driven by the productivity of the firm.

\[ H2: \] Productivity is, in turn, associated with innovation output.

The next section presents an outline of the empirical strategy in order to test our hypotheses.

\[ \text{Note: Year = 2004 and 2008; kernel = epanechnikov; bandwidth = 0.0764.} \]

\[ \text{Figure 12.1 Kernel distribution of productivity between innovative versus noninnovative firms, 2004 and 2006} \]
3. EMPIRICAL STRATEGY

3.1 Models of Innovation, Productivity and Exports

Most studies test the relationship of innovation and firms’ performance using R&D investments as a proxy for innovation. Although related, R&D investments are merely a part of innovation input. This input is the total innovation investment that, according to the *Oslo Manual*, consists of six innovation investment categories: intramural R&D, extramural R&D, machinery acquisition, other external knowledge gathering, training and market introduction of innovation (OECD, 2005). To assess the impact of innovation on firms’ performance, the focus must be placed on the outcome of knowledge production, which is the output of these innovation activities. Therefore it is crucial to distinguish innovation into input, consisting of R&D and other related investments, and output, as a successful result of such input. Innovation output can be measured accordingly as the fraction of total turnover due to innovative products.4

The empirical setting that allows for the distinction above can be traced back to Pakes and Griliches (1984), who introduce a knowledge-production function that can be written in its simplest form as

\[ \dot{k} = \sum r + u_1, \quad p = \dot{k} + u_2, \quad \text{and} \quad a = \sum r + u_3, \]

where \( \dot{k} \) denotes knowledge increment, \( r \) is expenditure in different research activities, \( p \) is the number of patents as inventive output, and \( u_i \) are the error terms assumed to be independent in all three equations. This setup disentangles the relationship between innovation input (captured by the knowledge increment variable) and productivity by providing an intermediate step, that is innovative output (measured as the number of patents). However, this set of equations suffers from an important econometric issue. Because the firms that enter the estimation are not randomly drawn from the whole population, the selection issue can arise and bias the resulting estimates. Moreover, because the innovation input is endogeneous in the innovation equation and the innovation output is endogeneous in the productivity equation, this can also lead to a simultaneity bias.

The seminal work of Crépon et al. (1998) (CDM hereafter) highlights these selectivity and simultaneity issues and solves the selection bias by introducing a selection equation in addition to the three-equation approach above and assuming the disturbance terms to be correlated.
Innovation and entrepreneurship in the global economy

across all four equations. Using an asymptotic least squares estimator, they provide a consistent estimate that corrects for both issues.

Lööf and Heshmati (2006) use a structural model that differs slightly from the CDM model. Instead of assuming all disturbances to be correlated, they separate the four equations into two parts – the selection equations (using the Heckman selection estimator) and the innovation-performance equations (using three-stage least squares: 3SLS).

The setup can be formulated as:

\[ g^* = \beta_{0,1} + \sum_n \beta_{n,1}x_{n,1} + \epsilon_1 \] (12.1)

\[ k^* = \beta_{0,2} + \sum_m \beta_{m,2}x_{m,2} + \epsilon_2 \] (12.2)

\[ i = \beta_{0,3} + \beta_k k + \beta IMR IMR + \sum_l \beta_{l,3}x_{l,3} + \epsilon_3 \] (12.3)

\[ p = \beta_{0,4} + \beta_i i + \beta e e + \sum_j \beta_{j,4}x_{j,4} + \epsilon_4 \] (12.4)

where the selection part contains \( g^* \), denoting innovation input propensity (a latent variable with value 1 if total innovation investment is positive) and \( k^* \), denoting innovation input intensity (logged total innovation investment per employee), which corresponds to the observed innovation input propensity – that is, \( g = 1 \) – and the last two equations consist of the innovation output and productivity, denoted \( i \) and \( p \). In this case, the disturbances from equations (12.1) and (12.2) are correlated, as are equations (12.3) and (12.4). The two parts are linked by \( IMR \) – the inverted Mills’ ratio from the selection equations in the previous step.

In Antonietti and Cainelli (2011), the authors investigate the role of spatial agglomeration in an extended model that involves the research equations, innovation output propensity, productivity and export propensity. The five-equation structural model can be written as:

Research equations:

\[ g^* = \beta_{0,1} + \sum_n \beta_{n,1}x_{n,1} + \epsilon_1 \] (12.5)

\[ k^* = \beta_{0,2} + \sum_m \beta_{m,2}x_{m,2} + \epsilon_2 \] (12.6)

Innovation equation:

\[ \Pr(i = 1|X = x_i) = \Phi(\beta_{0,3} + \beta_i k + \sum_l \beta_{l,3}x_{l,3} + \epsilon_3) \] (12.7)
Productivity equation: 
\[ p = \beta_{0,a} + \beta_{i,i} + \sum_{j} \beta_{j,j} x_{j,j} + \varepsilon_{4} \]  
(12.8)

Export equation:
\[ \Pr(e = 1|X = x_{s}) = \Phi(\beta_{0,5} + \beta_{p,p} + \sum_{s} \beta_{s,s} x_{s,s} + \varepsilon_{5}) \]  
(12.9)

where \( \Pr(i) \) and \( \Pr(e) \) denote the propensity of innovation output and exports, respectively. In this setup, the innovation equation (12.7) does not include the inverted Mills’ ratio from the research equations, (12.5) and (12.6), and the correlation of the error terms across equations is not assumed.

The analysis in this study resembles the structural model by Lööf and Heshmati (2006) in equations (12.1) to (12.4), with an additional equation for export performance, measured as logged export value per employee:

\[ e = \beta_{0,5} + \beta_{p,p} + \sum_{s} \beta_{s,s} x_{s,s} + \varepsilon_{5} \]  
(12.10)

3.2 The Full Model

The full model consists of all five equations: the innovation input equations (12.1) and (12.2), the innovation output equation (12.3), the productivity equation (12.4), and the export performance equation (12.10).

Equation (12.1) examines the decision of the firm to invest in innovation input. Here, \( x_{n,1} \) is a vector of the independent variables explaining the decision of the firm to invest in innovation. These variables include firm size (measured as logged number of employees), physical capital (logged sum of building, machinery and inventories), human capital (fraction of highly educated employees, with at least three years of university studies), and ownership structure variables (categorical variables indicating a firm as being non-affiliated, part of a uninalient corporate group, domestic MNEs, or foreign MNEs). The non-affiliated firms are the reference group. These explanatory variables mainly capture the core characteristics of firms in terms of internal resource allocation (size and physical capital) and knowledge capacity building (human capital). The corporate affiliation aims to differentiate the ownership structure among firms, in which multinationals are more likely to engage in R&D activities than firms that serve only the domestic market. All variables are expected to exhibit positive coefficients. Equation (12.2) considers the amount of
total innovation investment. Again, $x_{m,1}$ is a vector of explanatory variables, which is the same as $x_{n,1}$, except that $x_{m,1}$ does not include firm size. To provide consistent and more robust estimates, we follow the general practice of variable exclusion from the outcome equation. This means that the excluded variable is expected to be correlated with the probability of investing in R&D-related activities, but not with R&D intensity. Because one of the stylized facts among innovation studies indicates that R&D intensity is independent of firm size (Klette and Kortum, 2004), we drop firm size from equation (12.2).

Then, equation (12.3) explains the innovation output of the firm. This equation is also called the ‘innovation production function’. The predicted value of innovation input from the previous equation ($k$) is used as one of the regressors. A vector of explanatory variables, $x_{l,3}$, determines innovation output and includes similar variables as $x_{n,1}$ with the addition of a cooperation variable, indicating whether a firm has any formal cooperation agreements with external parties or not. This cooperation variable aims to capture the external factor of innovation outside the firms that can contribute to successful investments in innovation. The IMR variable is the inverted Mills’ ratio, used to correct for selection bias (Heckman, 1979), and is expected to show a statistically significant result. Here, the error term is assumed normal.

Equation (12.4) explains firms’ productivity. The predicted value of innovation output from the third equation ($i$) is used as a regressor. Similarly, $x_{l,4}$ includes the same variables as $x_{n,1}$. The error terms in equations (12.4) and (12.5) are assumed to be correlated, when we estimate the two equations jointly by the three-stage least squares (3SLS) estimator. Export intensity ($e$) is used as a simultaneous explanatory variable to allow for an interaction between productivity and exports. The inclusion of an export variable can capture firms’ learning from previous exporting to become more productive in later periods (Andersson and Lööf, 2009; Clerides et al., 1998).

Finally, equation (12.10) explains export performance. The $x_{s,5}$ vector of explanatory variables includes, in addition to $x_{l,4}$, firms’ productivity and previous export experience. Following the self-selection literature, we would expect productivity to exhibit a positive and significant result that corresponds to a greater engagement in export markets of productive firms. The experience variable is included to distinguish firms that have previously paid upfront fixed entry costs from new exporters.
3.3 Model Estimation

In this chapter, we employ two alternative estimation strategies in order to test the relationship between innovation input, innovation output, productivity and exports within the structural framework above. The first and preferred strategy is a three-step procedure. The second strategy is a two-step procedure. We compare these two alternative strategies at the end of this section and present the results for the two-step approach in the Appendix. The three-step procedure can be described as follows:

Step 1: Innovation input’s determinants (generalized Tobit model)
In this step, we estimate innovation input equations, equations (12.1) and (12.2), simultaneously by the generalized (Type-2) Tobit, sometimes called the Heckman selection model (Heckman, 1979). Because some firms that participate in the CIS do not report their innovation activity investments, the dependent variable is missing for these firms. Also these missing values are not random, which implies that there is a potential selection bias in the CIS data (Mairesse and Mohnen, 2010). The Heckman model is designed to handle such potential selection bias (Heckman, 1979). This implies that equation (12.1) is the selection equation in which innovation input propensity is the dependent variable. The outcome equation is, therefore, equation (12.2) and innovation input intensity is the dependent variable. We use the full-information maximum likelihood (FIML) estimator to jointly estimate the two equations. Alternatively, we could estimate them separately as a two-step procedure, with the first being probit, and the second being ordinary least squares (OLS) with the inclusion of the inverted Mills ratio in the second step. However, Verbeek (2008) shows that the first approach is superior to the two-step approach in terms of consistency and efficiency.

Step 2: Innovation input to innovation output (OLS)
In this step, we estimate innovation production function, equation (12.3), using OLS. The choice of the estimator is in line with recent advances in estimating the knowledge production function, which does not assume an interaction between innovation output and productivity, leaving OLS as a safe estimator (Mairesse and Robin, 2012). From the first step, we use the lagged predicted value of the dependent variable, namely innovation input intensity (of year 2004), as one of the main independent variables in this step to explain innovation output (in 2006). There are three reasons for this: (i) in order to link step 1 with step 2 as part of the structural model; (ii) in order to reduce the potential endogeneity problem by replacing the observed value of innovation input with its predicted value as an
Innovation and entrepreneurship in the global economy

An important issue is that this step limits the observations to a subsample of innovative firms (378 firms), since we are seeking to explain the innovation output ‘of innovative firms’. Innovative firms are defined as those firms that have positive innovation input (total investment in innovation activities) and positive innovation output (innovative sales) (Lööf and Heshmati, 2006). However, this may cause a selection bias, since the total sample is reduced to the non-random subsample of innovative firms (Crépon et al., 1998; Lööf and Heshmati, 2006). In order to deal with the selection bias, we include the inverted Mills’ ratio variable calculated from the first step as an additional regressor in this step.

Step 3: Innovation output to productivity and export (3SLS)

In the third and final step, we simultaneously estimate productivity and export equations, equations (12.4) and (12.5), using the three-stage least squares (3SLS) estimator. There are two reasons for the chosen estimator: (i) in order to deal with the simultaneity problem; and (ii) in order to allow for an interaction between productivity and export to test for the two non-mutually exclusive relationships concerning productivity and exporting, namely self-selection versus learning-by-exporting. An alternative estimator is two-stage least squares (2SLS), but 3SLS has a higher efficiency advantage over 2SLS by taking into account the correlation of the error terms between equations (Greene, 2003). We use the lagged predicted value of the innovation output from the previous step as an independent variable (in 2006) to explain subsequent productivity. The logic is the same as the three reasons for including predicted innovation input to explain innovation output, provided in step 2.

An alternative strategy for the three-step procedure is a two-step procedure. The first step in the two-step procedure is the same as above. In the second step of the two-step procedure, we allow for interaction of innovation output, productivity and export altogether (the result is reported in Table 12A.1 in the Appendix). We prefer and employ the three-step approach for the main findings in this chapter. This is because the three-step procedure has an additional lag structure – not only from innovation input to innovation output, as in the two-step procedure, but also from innovation output to productivity and exporting. In this way, we allow for the timing of innovation output to affect firms’ performance
and, additionally, the problem of endogeneity and reverse causality can be substantially reduced.

The main difference between the three- versus the two-step procedure is that in the three-step procedure, the predicted values from steps 1 and 2 are included as independent variables in the succeeding steps, 2 and 3, to reduce the simultaneity bias. The lagged structure of the independent variables takes into account the endogeneity issue. The productivity-export equations allow for interaction of productivity and exporting, which can help determine the relationship direction, that is, self-selection versus learning-by-exporting.

4. DATA

Our main data for the analysis come from Sweden’s Community Innovation Survey (CIS). The CIS is a pan-European cross-sectional survey that consists of microlevel national data on various aspects of firms’ innovation-related activities. This self-reported survey is conducted by the participating countries and the highly consistent questions and methodology among the countries are advantageous for cross-country comparisons. The survey is currently repeated every two years. For an overview of a growing group of empirical studies employing CIS data see Hall and Mairesse (2006).

For this study, the dataset contains two waves:10 CIS4, which covers the years 2002–04 and CIS2006, which covers the years 2004–06. The surveys are conducted by Statistics Sweden, with a response rate close to 70 percent, and cover both manufacturing and business service sectors.

The advantage of combining the two waves of CIS is the ability to capture a causal relationship between variables of interest and remove the simultaneity bias. So, in this case, the past values of innovation input can explain innovation output in the current period, instead of proxying it with the current values. The disadvantage is that the resulting dataset excludes firms that participate in only one of the two waves and thus reduces the observations for the analysis by about 5 percent. The total number of firms that participate in CIS4 is 1802 and 1764 for CIS2006, whereas this study uses 1718 firms.

We complement the CIS data by including the annual firms’ registry, ownership structure and export dataset by matching the encoded unique firm identification number. Therefore we can construct a panel dataset for firms that appear in both CIS waves to have a range from 2002 to 2009. Employing the official registry data is preferable to relying on the
Innovation and entrepreneurship in the global economy

self-reported data from the survey, which can suffer from ‘questionable quality’ (Lööf and Heshmati, 2006).

The description and descriptive statistics of all variables in this chapter are presented in Tables 12.1 and 12.2. We restrict our analysis to the manufacturing sector to focus on firms that export what they actually produce. This is because many exporting firms within the services sector are intermediate trading firms that distribute products from other domestic firms. So the cost structure is very different from that of manufacturing firms. The sample includes 1718 firms in total.

Table 12A.2 in the Appendix cross-tabulates all firms according to their innovation and exporting status in the same year. Table 12A.3 shows the ex post exporting status several years after the surveys. As we can see, exporters are associated with being innovative, and vice versa. Comparing the two tables, we also see that more innovative firms become exporters in later years, for example 700 and 650 in 2004 and 2006 to 727 and 678 in 2008–09. This shows that if we allow some lags for innovation, the effect on exporting will be more pronounced.

Table 12A.4 in the Appendix lists the correlations of all variables; the generally low correlation among variables seems to pose no multicollinearity problem for the analysis.

5. RESULTS AND DISCUSSION

As we elaborate in Section 3, the structural model is estimated in three steps: (1) the innovation input equation (Heckman); (2) the innovation production function (OLS); and (3) the productivity and export performance equations (3SLS). We present the results of steps 1 to 3 in Tables 12.3 to 12.5, respectively.

In Table 12.3, the joint estimation of innovation input equations, that is, equations (12.1) and (12.2), is reported. Column (1) is the selection equation corresponding to equation (12.1). The dependent variable is innovation input propensity, measured as a dummy with value 1 if total investment in innovation activities are positive from 2002 to 2004 (denoted by 2004) and from 2004 to 2006 (denoted by 2006). Column (2) is the outcome equation corresponding to equation (12.2). The dependent variable is innovation input intensity, measured as logged total investment in innovation activities per employee, observed at the same time as innovation input propensity.

Table 12.3 shows that both physical capital and human capital have a positive and significant influence on both the decision and the intensity of innovation input. Firms with more resources are more likely to invest in
### Table 12.1 Description of variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
<th>Source</th>
<th>Expected sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm size</td>
<td>Total number of employees in current year</td>
<td>Firm’s registry database</td>
<td>+</td>
</tr>
<tr>
<td>Physical capital</td>
<td>Total costs of building, land and machinery, in current SEK</td>
<td>Firm’s registry database</td>
<td>+</td>
</tr>
<tr>
<td>Human capital</td>
<td>Share of highly educated employees with at least three years of tertiary education per total employees</td>
<td>Firm’s registry database</td>
<td>+</td>
</tr>
<tr>
<td>Uninational</td>
<td>Dummy taking value 1 if the firm belongs to a domestic corporation group, 0 otherwise</td>
<td>Firm’s ownership structure database</td>
<td>+/−</td>
</tr>
<tr>
<td>Domestic MNEs</td>
<td>Dummy taking value 1 if the firm is affiliated with Swedish multinational enterprises, 0 otherwise.</td>
<td>Firm’s ownership structure database</td>
<td>+/−</td>
</tr>
<tr>
<td>Foreign MNEs</td>
<td>Dummy taking value 1 if the firm is affiliated with multinational enterprises with headquarter(s) outside of Sweden, 0 otherwise</td>
<td>Firm’s ownership structure database</td>
<td>+/−</td>
</tr>
<tr>
<td>Cooperation</td>
<td>Dummy taking value 1 if the firm has a formal external cooperation agreement, 0 otherwise</td>
<td>CIS</td>
<td>+</td>
</tr>
<tr>
<td>Innovation input propensity</td>
<td>Dummy taking value 1 if the firm has positive investments in innovation input</td>
<td>Author-generated using CIS data</td>
<td>+</td>
</tr>
<tr>
<td>Innovation input</td>
<td>Total investments in at least one of the six categories in innovation-related activities, according to the Oslo Manual, in SEK</td>
<td>CIS</td>
<td>+</td>
</tr>
<tr>
<td>Innovation output</td>
<td>Total sales for innovative products, in SEK</td>
<td>CIS</td>
<td>+</td>
</tr>
<tr>
<td>Productivity</td>
<td>Value added per employee, in SEK</td>
<td>Firm’s registry database</td>
<td>+</td>
</tr>
<tr>
<td>Export intensity</td>
<td>Total export value, in SEK</td>
<td>Firm’s export database</td>
<td>+</td>
</tr>
<tr>
<td>Export experience</td>
<td>Dummy taking value 1 if the firm has had exporting experience during 1997–2002, 0 otherwise</td>
<td>Author-generated using firm’s export database</td>
<td>+</td>
</tr>
</tbody>
</table>
innovation activities. This is in line with previous studies using CIS data (Crépon et al., 1998; Lööf and Heshmati, 2006). Ownership structure variables are significant only for domestic MNEs, meaning that there is a significant difference if a firm belongs to Swedish MNEs or not when it comes to innovation decisions, while it makes no difference for firms belonging to a uninational corporate group and foreign MNEs. The decision to invest seems more important for Swedish MNEs in order to compete in international markets. On the contrary, this decision is not as important for a uninational corporation that serves only the domestic market or for foreign MNEs because such investments are more likely to be conducted close to the headquarters and less likely at the subsidiaries abroad.

Table 12.4 reports the estimation of innovation production function, equation (12.3), for innovative firms using OLS. The dependent variable is innovation output, measured as logged innovative sales per employee from 2004 to 2006 (denoted by 2006). The main independent variable is lagged innovation input from 2002 to 2004 (denoted by 2004), which is predicted from the previous step (from Table 12.3).

Table 12.4 shows that past innovation input has a positive (but weakly) significant effect on innovation output, as expected. Firm size and capital also have positive and significant effects on innovation output of innovative firms. Two of the ownership structure variables, domestic and foreign
MNEs, are significant and positive. The results for the ownership variables resonate with those in the first step, where it is more important for Swedish MNEs than for uninational corporation or foreign MNEs.

The last step of the estimation is reported in Table 12.5. Here, we estimate equations (12.4) and (12.10) simultaneously. The chosen estimator is 3SLS.

The predicted lagged innovation output in 2006 is used as the main explanatory variable for productivity. This variable is obtained from the second step (Table 12.4). The dependent variables are productivity and export performance measured as total export value during 2008–09, columns (4) and (5).

### Table 12.3 Step 1 – innovation input determinants

Dependent variable: Innovation input *(logged total innovation investment per employee)*

Estimation: Generalized Tobit model (Heckman using FIML)

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1) Selection equation</th>
<th>(2) Outcome equation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm size (log) (2004, 2006)</td>
<td>0.235***</td>
<td></td>
</tr>
<tr>
<td>Physical capital (log) (2004, 2006)</td>
<td>0.122***</td>
<td>0.330***</td>
</tr>
<tr>
<td>Uninational</td>
<td>0.114</td>
<td>0.180</td>
</tr>
<tr>
<td></td>
<td>(0.079)</td>
<td>(0.141)</td>
</tr>
<tr>
<td>Domestic MNEs</td>
<td>0.277***</td>
<td>0.219*</td>
</tr>
<tr>
<td></td>
<td>(0.097)</td>
<td>(0.133)</td>
</tr>
<tr>
<td>Foreign MNEs</td>
<td>0.077</td>
<td>0.181</td>
</tr>
<tr>
<td></td>
<td>(0.099)</td>
<td>(0.137)</td>
</tr>
<tr>
<td>Constant</td>
<td>−3.416***</td>
<td>−2.749*</td>
</tr>
<tr>
<td></td>
<td>(0.531)</td>
<td>(1.513)</td>
</tr>
<tr>
<td>Observations</td>
<td>2135</td>
<td></td>
</tr>
<tr>
<td>Uncensored obs.</td>
<td>—</td>
<td>1244</td>
</tr>
<tr>
<td>Industry dummies</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year dummies</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Notes:
Robust standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.
LR test of independence: $\chi^2(1) = 35.77$ with $p = 0.000$. 

MNEs, are significant and positive. The results for the ownership variables resonate with those in the first step, where it is more important for Swedish MNEs than for uninational corporation or foreign MNEs. 

The last step of the estimation is reported in Table 12.5. Here, we estimate equations (12.4) and (12.10) simultaneously. The chosen estimator is 3SLS.

The predicted lagged innovation output in 2006 is used as the main explanatory variable for productivity. This variable is obtained from the second step (Table 12.4). The dependent variables are productivity and export performance measured as total export value during 2008–09, columns (4) and (5).
Innovation and entrepreneurship in the global economy

From the results of productivity equation in Table 12.5, innovation output is positive and significant, which means that we can reject the null hypothesis 2 \((H_2)\). A doubling increase in innovation output is associated with 16.1 percent increase in firm’s productivity. The finding is in line with other similar studies. Our estimate size 0.161 is slightly higher than 0.121 in Lööf and Heshmati (2006). In Crépon et al. (1998), the asymptotic least squares estimate in the second step is 0.308, or roughly twice compared to our result. Antonietti and Cainelli’s (2011) measure of innovation output is a binary variable, but they also find a positive and significant effect of innovation output on firms’ total factor productivity.

Table 12.4  Step 2 – innovation input to innovation output

<table>
<thead>
<tr>
<th>Variables</th>
<th>(3) Innovation output (_{2006})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation input ((Predicted)) ((lagged: 2004))</td>
<td>0.333*</td>
</tr>
<tr>
<td>Firm size ((log)(lagged: 2004))</td>
<td>0.370***</td>
</tr>
<tr>
<td>Physical capital ((log)(lagged: 2004))</td>
<td>0.347***</td>
</tr>
<tr>
<td>Human capital ((log)(lagged: 2004))</td>
<td>3.068***</td>
</tr>
<tr>
<td>Cooperation ((lagged: 2004))</td>
<td>0.038</td>
</tr>
<tr>
<td>Uninational</td>
<td>0.199</td>
</tr>
<tr>
<td>Domestic MNEs</td>
<td>0.730***</td>
</tr>
<tr>
<td>Foreign MNEs</td>
<td>0.463*</td>
</tr>
<tr>
<td>Inverted Mills ratio ((2006))</td>
<td>5.071***</td>
</tr>
<tr>
<td>Constant</td>
<td>0.333*</td>
</tr>
<tr>
<td>Observations (innovative firms)</td>
<td>378</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.131</td>
</tr>
<tr>
<td>Industry dummies</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Notes: Bootstrapped standard errors in parentheses; *** \(p < 0.01\), ** \(p < 0.05\), * \(p < 0.1\).
The positive and highly significant result for productivity suggests that it can explain export performance, which is in line with the self-selection literature (Melitz, 2003, among others). This means that we can reject the null hypothesis 1 (H1). It also implies that we find significant evidence that export intensity is driven by firms’ productivity level. In terms of magnitude, a doubling increase in firms’ productivity level leads to an increase in export value by approximately twice. Although other studies
have used different measures of exports, for example share of export per total sales or the number of destination regions, they also find this positive effect of productivity of firms’ exports (Antonietti and Cainelli, 2011; Wagner, 2007).

On the other hand, exports are not significant in explaining productivity, which means that this chapter does not find evidence to support the learning-by-exporting argument. For past export experience, it is positive and highly significant in explaining current export performance, confirming the persistency of exporting. Furthermore, physical capital and human capital are also positive and significant in explaining productivity, as we expect. Ownership structure variables, that is, domestic and foreign MNEs, are positive and significant only for export performance.

In summary, the structural framework adopted in this chapter reveals the mechanics behind the export behavior of firms. Productive firms become exporters and there is no evidence that exporting leads a firm to be productive. The source of such productivity heterogeneity is the innovative performance (output) of firms in the past. Lastly, such innovative output is the result of the amount of investment in innovation activities and the decision to invest in the past.

As an alternative approach, we allow for interaction of innovation output, productivity and exporting in a simultaneous setting. Table 12A.1 in the Appendix lists the results. We first estimate the three equations, equations (12.3), (12.4) and (12.10), separately by OLS, then simultaneously by 3SLS. The Hausman test rejects the null hypothesis of simultaneity. Once again, the results suggest that lagged innovation input has an impact on current innovation output, and productivity has an impact on export intensity. This means using an alternative estimation strategy does not change our main results.

Export intensity is positive and significant in explaining both innovation output and productivity. However, the positive impact on productivity is not in line with the results based on a three-step procedure estimation strategy. One possible reason may be the difference in timing between the two methodologies; that is, the two-step approach treats both exports and productivity in the same year, whereas the three-step approach has a lag of two years. We prefer to rely more on the three-step procedure estimation strategy since it allows us to use the lag in our structural equations. Moreover, the mixed results seem to be common in empirical studies dealing with the productivity–export association (e.g. in a cross-country study by ISGEP, 2008).
6. CONCLUSION

It is well known that exporters are productive firms. But the source of their productivity is left unexplained. This chapter aims to endogenize the productivity heterogeneity of exporting firms by incorporating innovation in a structural model framework. In doing so, we close the gap between the innovation–productivity and productivity–export literature.

There are two novelties in this chapter. First, we open the black box concerning the source of productivity heterogeneity of exporting firms. Although we know that productive firms can start exporting later, we answer the question why those firms are productive in the first place. Second, by merging the two waves of Swedish CIS data and tracing the participants’ behavior from 2002 to 2009, it becomes possible (i) to consider the lagged value of innovation input to explain future innovation output, and then (ii) to consider innovation output to explain further future productivity and export performance. It implies that we (i) allow a lead time for innovation input to impact on innovation output and (ii) leave time for innovation output to have its effect on productivity and export performance. Such a structure can substantially reduce the reverse causality and endogeneity bias.

The main findings are that exporters are productive firms that cross the productivity threshold. They have passed it because they succeeded in appropriating innovation output in the past, which is driven in turn by the decision and amount of investment in various investments in innovation activities.

The implication of the findings is that export promotion policies could be more effective if they targeted firms that have succeeded in their innovation activities. This is because these innovative firms are more likely to improve their productivity and will be more likely to afford the entry costs of exporting later. Note that the amount of firms’ innovation investments alone may not necessarily lead to a desirable objective, but the output as a result of a successful investment does.

ACKNOWLEDGMENT

Financial support from the Torsten Söderberg Foundation is gratefully acknowledged.
NOTES

1. Other studies have found the same pattern. See the review by Wagner (2007).
2. Recent studies are based on innovation survey data. For a review, see Hall and Mairesse (2006).
3. Antonietti and Cainelli (2011); Aw et al. (2008); Aw et al. (2011) are some exceptions.
4. Innovation output is further divided into new to the firm and new to the market. In this study, the focus is on the former and not necessarily the latter.
5. This categorical variable for ownership structure is a registered datum obtained from Statistics Sweden. We prefer using this categorical variable to a dichotomous variable in CIS data indicating whether a firm belongs to a group or not. This type of substitution is argued to be useful for improving the quality of an empirical analysis in CIS data (Mairesse and Mohnen, 2010).
6. Unfortunately, the data do not allow us to construct the market share variable, which is common in a study of this kind (see how to construct the variable in Crépon et al., 1998). It is expected to be positively related to R&D.
7. The main explanatory variable for innovation output is innovation input (intensity). However, this variable is argued to be potentially an endogenous variable, since unobserved characteristics could increase both firms’ innovation input efforts and innovativeness (Mairesse and Robin, 2012; Mohnen et al., 2006). Furthermore, it is suggested that predicted value (instead of observed value) can act as an instrument and reduce the endogeneity problem (Lööf and Heshmati, 2006; Mairesse and Robin, 2012).
8. There are good reasons to believe that innovation input (investments) takes time to exhibit its effect on innovation output (innovative sales). Studies using ‘patent’ usually use two or three years’ lag between innovation input and output (Fritsch and Slavtchev, 2007; Ponds et al., 2010). However, CIS studies have seldom considered such lag structure, due to the cross-sectional nature of CIS data. Nevertheless, thanks to merging the two waves of CIS, this chapter is able to use the lag structure in the analysis.
9. Here, productivity and export are endogenous variables and the other variables are exogenous in this step.
10. Although it is ideal to include three waves to test the recursive relationships from productivity and exporting back to innovation input, the attempt to merge the three waves does not yield a dataset with adequate observations. The variation in many of the variables is rather small, so that most of the estimates do not have significant results.

REFERENCES


APPENDIX

Table 12A.1  Step 2 – innovation output, productivity and export performance

Dependent variables: Innovation: \( \text{logged innovative sales per employee} \); Productivity: \( \text{logged value added per employee} \); and Export: \( \text{logged total export value per employee} \)

Estimation: Equation-by-equation OLS, simultaneous equations (3SLS) with bootstrapped standard errors

<table>
<thead>
<tr>
<th>Variables</th>
<th>(6) Innovation output</th>
<th>(7) Productivity</th>
<th>(8) Export intensity</th>
<th>(9) Innovation output</th>
<th>(10) Productivity</th>
<th>(11) Export intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation input</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{Predicted} ) (lagged:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.292**</td>
<td>(0.129)</td>
<td></td>
<td></td>
<td>0.288*</td>
<td>(0.151)</td>
<td></td>
</tr>
<tr>
<td>Innovation output</td>
<td></td>
<td>0.011</td>
<td></td>
<td></td>
<td>0.007</td>
<td></td>
</tr>
<tr>
<td>( \text{log} ) (2006)</td>
<td></td>
<td>(0.056)</td>
<td></td>
<td></td>
<td>(0.062)</td>
<td></td>
</tr>
<tr>
<td>Productivity</td>
<td></td>
<td></td>
<td>4.388***</td>
<td></td>
<td>4.414***</td>
<td>(0.764)</td>
</tr>
<tr>
<td>( \text{log} ) (2006)</td>
<td></td>
<td></td>
<td>(0.813)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Export intensity</td>
<td></td>
<td>0.197*</td>
<td>0.122***</td>
<td></td>
<td>0.199*</td>
<td>0.123***</td>
</tr>
<tr>
<td>( \text{log} ) (2006)</td>
<td></td>
<td>(0.104)</td>
<td>(0.023)</td>
<td></td>
<td>(0.112)</td>
<td>(0.029)</td>
</tr>
<tr>
<td>Export experience</td>
<td></td>
<td></td>
<td>2.393</td>
<td></td>
<td>2.370</td>
<td></td>
</tr>
<tr>
<td>( \text{2006} )</td>
<td></td>
<td></td>
<td>(2.574)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Process innovation</td>
<td></td>
<td>0.005</td>
<td></td>
<td></td>
<td>0.004</td>
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</tr>
<tr>
<td>( \text{2006} )</td>
<td></td>
<td>(0.036)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Size</td>
<td></td>
<td>0.016</td>
<td>-0.175***</td>
<td></td>
<td>0.015</td>
<td>-0.176***</td>
</tr>
<tr>
<td>( \text{log} ) (2006)</td>
<td></td>
<td>(0.057)</td>
<td>(0.063)</td>
<td></td>
<td>(0.062)</td>
<td>(0.066)</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------</td>
<td>-----------------</td>
<td>-----------------------</td>
<td>-----------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical capital</td>
<td>0.021</td>
<td>0.059***</td>
<td>0.019</td>
<td>0.059***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.074)</td>
<td>(0.020)</td>
<td>(0.067)</td>
<td>(0.018)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human capital</td>
<td>1.335*</td>
<td>0.617***</td>
<td>1.318*</td>
<td>0.620**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.744)</td>
<td>(0.214)</td>
<td>(0.758)</td>
<td>(0.261)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperation</td>
<td>0.098</td>
<td>0.096</td>
<td>0.098</td>
<td>0.096</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.114)</td>
<td></td>
<td>(0.142)</td>
<td></td>
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<tr>
<td>Uninational</td>
<td>−0.207</td>
<td>−0.005</td>
<td>0.036</td>
<td>−0.209</td>
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<td></td>
<td>(0.204)</td>
<td>(0.079)</td>
<td>(0.472)</td>
<td>(0.255)</td>
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<tr>
<td>Domestic MNEs</td>
<td>−0.269</td>
<td>−0.027</td>
<td>1.110***</td>
<td>−0.277</td>
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<td></td>
<td>(0.238)</td>
<td>(0.080)</td>
<td>(0.418)</td>
<td>(0.296)</td>
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<tr>
<td>Foreign MNEs</td>
<td>−0.393</td>
<td>−0.053</td>
<td>1.230***</td>
<td>−0.399</td>
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<tr>
<td></td>
<td>(0.262)</td>
<td>(0.082)</td>
<td>(0.406)</td>
<td>(0.285)</td>
<td></td>
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</tr>
<tr>
<td>Inverted Mills ratio</td>
<td>1.360*</td>
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<td>1.322</td>
<td></td>
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<tr>
<td></td>
<td>(0.777)</td>
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<td>(0.873)</td>
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<td>Constant</td>
<td>7.161***</td>
<td>10.890***</td>
<td>−48.264***</td>
<td>7.210***</td>
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<tr>
<td></td>
<td>(1.694)</td>
<td>(0.730)</td>
<td>(11.116)</td>
<td>(2.152)</td>
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<td>Observations</td>
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<td>0.406</td>
<td>0.131</td>
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</tr>
<tr>
<td>Industry dummies</td>
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<td>NO</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:  
Bootstrapped standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.  
† Hausman test of OLS versus 3SLS rejects the null hypothesis of simultaneity.
### Table 12A.2  Export and innovation status of firms by year

<table>
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<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firms</td>
<td>%*</td>
<td>Firms</td>
</tr>
<tr>
<td>Innovators (2004)</td>
<td>700</td>
<td>40.75</td>
<td>200</td>
</tr>
<tr>
<td>Noninnovators (2004)</td>
<td>427</td>
<td>24.85</td>
<td>391</td>
</tr>
<tr>
<td>Innovators (2006)</td>
<td>650</td>
<td>37.83</td>
<td>189</td>
</tr>
<tr>
<td>Noninnovators (2006)</td>
<td>476</td>
<td>27.71</td>
<td>403</td>
</tr>
</tbody>
</table>

**Notes:** * Percentage of total number of firms = 1718. The year of export status corresponds to innovation status, e.g. 700 firms are innovators in 2004 and are also exporters in 2004.

### Table 12A.3  Export status of firm in later years

<table>
<thead>
<tr>
<th></th>
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</tr>
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<tbody>
<tr>
<td></td>
<td>Firms</td>
<td>%*</td>
<td>Firms</td>
</tr>
<tr>
<td>Innovators (2004)</td>
<td>727</td>
<td>42.32</td>
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</tr>
<tr>
<td>Noninnovators (2004)</td>
<td>350</td>
<td>20.37</td>
<td>468</td>
</tr>
</tbody>
</table>

**Notes:** * Percentage of total number of firms = 1718. The year of innovation status is 2004 and 2006, whereas the year of export status is 2008 and 2009.
Table 12A.4  Correlation table

<table>
<thead>
<tr>
<th></th>
<th>Firm size</th>
<th>Physical capital</th>
<th>Human capital</th>
<th>Uninational</th>
<th>Domestic MNEs</th>
<th>Foreign MNEs</th>
<th>Coop.</th>
<th>Inno. input propensity</th>
<th>Inno. input</th>
<th>Inno. output</th>
<th>Productivity</th>
<th>Export intensity</th>
<th>Export experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm size</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Physical capital</td>
<td>0.240***</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human capital</td>
<td>0.085**</td>
<td>-0.177***</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uninational</td>
<td>-0.283***</td>
<td>-0.017</td>
<td>-0.092**</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic MNEs</td>
<td>0.179***</td>
<td>-0.014</td>
<td>0.080**</td>
<td>-0.367***</td>
<td>1.000</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Foreign MNEs</td>
<td>0.324***</td>
<td>0.074*</td>
<td>0.039</td>
<td>-0.356***</td>
<td>-0.483***</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cooperation</td>
<td>0.267***</td>
<td>0.124***</td>
<td>0.188***</td>
<td>-0.113***</td>
<td>0.119***</td>
<td>0.016</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inno. input propensity</td>
<td>0.086**</td>
<td>0.110***</td>
<td>0.028</td>
<td>0.018</td>
<td>0.047</td>
<td>-0.045</td>
<td>0.151***</td>
<td>1.000</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Innovation input</td>
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<td>0.083**</td>
<td>0.113***</td>
<td>-0.056</td>
<td>0.047</td>
<td>-0.032</td>
<td>0.185***</td>
<td>0.444*** 1.000</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Innovation output</td>
<td>0.052</td>
<td>0.042</td>
<td>0.129***</td>
<td>-0.126***</td>
<td>0.015</td>
<td>0.101**</td>
<td>0.124***</td>
<td>0.014 0.195*** 1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Productivity</td>
<td>0.254***</td>
<td>0.282***</td>
<td>0.249***</td>
<td>-0.127***</td>
<td>0.050</td>
<td>0.186***</td>
<td>0.188***</td>
<td>0.003 0.011 0.219*** 1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Export intensity</td>
<td>0.110***</td>
<td>0.184***</td>
<td>-0.106***</td>
<td>-0.213***</td>
<td>0.211***</td>
<td>0.084**</td>
<td>0.126***</td>
<td>0.101** 0.073* 0.143*** 0.168*** 1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Export experience</td>
<td>0.143***</td>
<td>0.014</td>
<td>-0.040</td>
<td>-0.155***</td>
<td>0.124***</td>
<td>0.067*</td>
<td>0.087**</td>
<td>0.008 0.053 0.083** 0.076* 0.321*** 1.000</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Notes:  * p < 0.05, ** p < 0.01, *** p < 0.01.
13. Infrastructure endowment, social capital and outsourcing: evidence from Emilia Romagna, Italy

Roberto Antonietti, Maria Rosaria Ferrante and Riccardo Leoncini

1. INTRODUCTION

Thanks to the higher availability of firm-level data, the empirical literature on ‘make-or-buy’ has exploded in the last 30 years. Despite this, some important issues have not yet been adequately investigated. Among them, one concerns the decision to make and buy, that is, the decision to partly outsource production or service activities, while another relates to the influence of the external environment on the subcontracting strategy to be adopted. In this chapter we try to fill this gap by investigating the effect of two characteristics of the context in which firms operate, namely social capital and transport infrastructures, on the decision to fully or partially outsource production activities. Specifically, we study whether firms’ propensity to contract out domestic production activities increases with the level of local social capital, and whether this effect depends on the local endowment of transport infrastructures.

We contribute to the existing literature in two ways. First, we enlarge our understanding of the mechanisms through which the environment in which firms are settled affects their organization of production and vertical boundaries. Second, we extend the analysis on local trust and the governance of transactions by looking at the different impact of lower opportunism in favouring subcontracting when monitoring and transport costs are (indirectly) included.

To accomplish this task, we exploit a rich dataset that collects a large amount of information on machine-tool firms located in the Emilia Romagna region of Italy in year 2005, which we combine with information on local transport infrastructures. Emilia Romagna is a very interesting ‘case study’ as it is by far the most known, studied and successful case of industrial-district-based economic development. Indeed, the outstanding
results that the region has obtained in terms of industrial performance solicited the attention of very important early studies on industrial districts’ performance (e.g. Brusco, 1982; Piore and Sabel, 1984; Best, 1990).

Emilia Romagna is also an interesting example of regional branching based on knowledge transfer across related sectors:

Many successful sectors like ceramic tiles, the packaging industry and robotics emerged out of a pervasive regional knowledge base in engineering. These sectors not only built and expanded on this extensive knowledge base, they also renewed and broadened the regional economy of Emilia Romagna. (Boschma, 2009, p. 9)

Our estimates show that the likelihood of fully outsourcing production activities increases with the local level of social capital, and is higher when the density of infrastructure of the local area is higher. On the other hand, when firms partially outsource production activities, social capital is never statistically significant, regardless of the infrastructure endowment of the region. We thus argue that easier mobility (i.e. lower transport costs) and local trust are two forces that complement each other when monitoring costs are high. Instead, when firms can easily monitor the outsourcing process, social capital becomes unnecessary.

It is worth mentioning that we refer to outsourcing in general terms, without distinguishing between domestic and international outsourcing, or offshoring. As will be clear in the following, the dataset we used in our empirical analysis does not provide any information on suppliers’ location. However, as documented in the literature on outsourcing (Ono, 2007; Holl, 2008; Cusmano et al., 2009; Mazzanti et al., 2009, 2011), as well as in the literature on industrial districts (Brusco, 1982; Becattini, 1990) and on machine-tool industries in Italy (Russo, 2008), outsourcing is mainly a local phenomenon.

The rest of the chapter is organized as follows. Section 2 provides a short literature review on the determinants of outsourcing, with a focus on social capital, and formulates the testable hypotheses. Section 3 describes the dataset (3.1) and the empirical strategy adopted (3.2). Section 4 presents the estimation results. Section 5 concludes.

2. LITERATURE REVIEW AND TESTABLE HYPOTHESES

When dealing with production outsourcing, the most relevant stream of literature is that on transaction costs (Coase, 1937; Williamson, 1975, 1985, 2005). The decision to outsource rather than produce in house depends
on the level of transaction costs, which, in turn, depends on a series of elements such as contractual incompleteness, asset specificity, market and technological uncertainty, information asymmetries and the risk of opportunistic behaviour by the counterpart. According to Williamson (1996), the vertical boundaries of the firm are determined not only by transaction attributes, but also by the characteristics of the surrounding environment, in particular by the societal culture for economic organization. Indeed, ‘[i]n the absence of trust, it would become very costly to arrange for alternative sanctions and guarantees, and many opportunities for mutually beneficial cooperation would have to be foregone’ (Arrow, 1970, p. 20).

Therefore locally available social capital should play a relevant role in driving the make–buy decision because, following Putnam et al. (1993), it is a system of shared values and beliefs that should prevent or reduce opportunistic behaviour by favouring trust building and mutual cooperation among people. For these reasons, social capital is particularly important in affecting market relationships because it reduces the need for hierarchical relationships and for vertically integrated structures (Williamson, 1985). In areas characterized by a high level of social capital, we should expect a higher propensity to cooperate, either because of moral obligation or because of fear of social punishment in case of cheating behaviour. This should lead firms to resort more frequently to outsourcing.

As summarized by Westlund and Adam (2010), our measure of social capital is the most utilized in the literature studying the effect of social capital on economic performance. However, a trust-based measure of social capital is not without problems. First, it may be that trust is strongly context-dependent, or particularly specific to a sector of a society. Second, trust in other people, as well as associations, does not necessarily mean trust in the whole economic system in which firms operate. Third, the level of social capital may depend on the spatial scale of aggregation, being more uniform (and stronger) when referred to lower units of analysis (i.e. firms) and more heterogeneous when measured on more aggregate areas, such as regions or countries. Fourth, trust and propensity to cooperate are not the only components of social capital: other important values to be considered are attitude to risk, entrepreneurial propensity, creativity, tolerance and civic traditions. Moreover, associations and interpersonal relations capture only a fraction of all types of network relationships occurring in an economic system.

Although a comprehensive measurement of social capital is well beyond the scope of this chapter, we use two alternative indices of ‘negative’ social capital, based on the propensity of local actors to behave opportunistically or even fraudulently. In addition, conscious that social capital is also the result of historical relations among actors, we provide an instrumental
variable analysis where social capital is explained by historical data on past foreign domination in Emilia Romagna.

In addition to social capital, we consider a second element, that is, local infrastructure endowment. The rationale for considering (transport) infrastructures is the following: a denser infrastructure endowment should facilitate accessibility and mobility, thus lowering transport costs; with lower transport costs, trade and market transactions are cheaper, delivery prices lower and, more importantly, the probability for agents to establish face-to-face contacts is higher.\(^2\) Despite their recognized (and highly debated) economic role,\(^3\) transport infrastructures have rarely been considered as a determinant of outsourcing.

In this chapter, we fill this gap by treating them as a tool that should strengthen the effect of local trust on transaction governance. If mutual trust is established through reciprocal contacts and visibility, we should expect social capital to affect economic behaviour more directly and easily when the availability of transport infrastructures in a certain area is higher.

In addition, in this work we argue that the relationship between social capital and outsourcing depends on the type of outsourcing strategy adopted, that is, full or partial. These two strategies, in turn, involve different monitoring costs (Parmigiani, 2007; Parmigiani and Mitchell, 2009; Heide et al., 2013; Puranam et al., 2013). We here assume that, when firms fully outsource (FO) production activities, the capability to monitor external suppliers and the quality of the service provided is low and monitoring costs are high; in this case, firms can compensate for higher monitoring costs by ‘relying’ on local social capital. If social capital is high, then mutual trust between clients and suppliers is also high, and the need to monitor the entire outsourcing process is low because the risk of social sanction prevents potential cheaters from deviating from the contract.

When firms partially outsource (PO) production, they maintain control over the production process, so they can better evaluate the quality of suppliers’ service, and they can reliably use the threat of backward integration in case of insolvency (Heide et al., 2013). In the PO case, monitoring costs are low and there should be no need for subcontracting firms to rely on local social capital to prevent delay.

With all these premises, we formulate the following two testable hypotheses:

**H1:** All other things being equal, belonging to an area characterized by higher social capital should increase the likelihood of fully outsourcing production activities. Such a relationship should hold in regions with a high endowment of transport infrastructures.
H2: All other things being equal, the likelihood to partially outsource production activities should not be affected by social capital, regardless of the degree of local infrastructure endowment.

3. DATA AND EMPIRICAL STRATEGY

3.1 The Dataset

The data come from the Sector Studies (Studi di Settore), developed by the Italian Fiscal Authority (Agenzia delle Entrate) for establishing a benchmark of relevant fiscal data and providing a detailed picture of firms’ fiscal positions. Sector Studies are an instrument settled in 1993 (Law no. 331, 30 August) aimed at collecting systematic and reliable information on the activities of small and medium-sized firms. This information is used for determining their capability to generate income and pay taxes. The questionnaires are designed and administered by the Italian Fiscal Authority (Agenzia delle Entrate) and the Italian Ministry of Economy and Finance, and are industry-specific.

In this chapter we use firm-level data collected for the year 2005 and for the Emilia Romagna region in Italy. These data were obtained under a formal agreement between the University of Bologna (Department of Statistical Sciences), Emilia-Romagna Region and the Italian Statistical Institute (ISTAT). We obtained a dataset of about 4500 firms belonging to the machine-tool industry (NACE code C28, ATECO 2002 code D29), and employing fewer than 100 (i.e. annual turnover of less than €5164169). After purging the data of missing values in the variables of interest, and deleting a small and unrepresentative set of firms with more than 50 employees, we obtained a final sample of 3280 firms. Table 13.1 shows the distribution of firms by province and compares the employment size composition of our sample with 2001 census data from ISTAT: we note a slight over-representation of firms belonging to the 10–49 employment class.

A map of the provinces of Emilia Romagna region is provided in Figure 13.1.

Data on local infrastructure endowment come from Montini and Zoboli (2007). Data on roads and railroads (in km) endowment at national level are extracted from the CD-Rom ‘GIS Italia 1995’. Then, using Arcview GIS software, the national network of infrastructures has been ‘divided’ at municipal level, and then re-aggregated at provincial level (NUTS-3 regions). With these data, we compute a measure of infrastructure density (DINFRA), given by the total amount (in km) of
Table 13.1  Distribution of firms by employment class and provinces

<table>
<thead>
<tr>
<th>Employment class</th>
<th>Census 2001</th>
<th>Our sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–9</td>
<td>75.4</td>
<td>70.70</td>
</tr>
<tr>
<td>10–49</td>
<td>24.6</td>
<td>29.30</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Province (NUTS3)</th>
<th>Number of firms</th>
<th>%</th>
<th>Number of firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bologna</td>
<td>747</td>
<td>22.77</td>
<td></td>
</tr>
<tr>
<td>Ferrara</td>
<td>155</td>
<td>4.73</td>
<td></td>
</tr>
<tr>
<td>Forlì-Cesena</td>
<td>202</td>
<td>6.16</td>
<td></td>
</tr>
<tr>
<td>Modena</td>
<td>595</td>
<td>18.14</td>
<td></td>
</tr>
<tr>
<td>Parma</td>
<td>529</td>
<td>16.13</td>
<td></td>
</tr>
<tr>
<td>Piacenza</td>
<td>190</td>
<td>5.79</td>
<td></td>
</tr>
<tr>
<td>Ravenna</td>
<td>211</td>
<td>6.43</td>
<td></td>
</tr>
<tr>
<td>Reggio Emilia</td>
<td>508</td>
<td>15.49</td>
<td></td>
</tr>
<tr>
<td>Rimini</td>
<td>143</td>
<td>4.36</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3280</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>


Figure 13.1  Map of Emilia Romagna region

roads (national roads and highways) and railroads per square kilometre of provincial area. Table 13.2 shows the distribution of this variable across provinces of the Emilia Romagna region and some descriptive statistics.
3.2 Empirical Strategy

Our dependent variables are defined as follows. In the questionnaire, firms report which production phase is actually accomplished in house or externally through full or partial outsourcing. We then define a first dummy equal to 1 if the firm fully outsources (FO) at least one of its production phases, and 0 otherwise. Then we define a second dummy equal to 1 if the firm partially outsources (PO) at least one of its production phases, and 0 otherwise. In this way, the share of firms fully outsourcing production is 53.5 per cent, while that of firms partially outsourcing is 39.6 per cent. Since there are firms that fully outsource certain phases while partially outsourcing other phases, FO and PO are not mutually exclusive, and show a correlation of 0.351 (significant at the 1 per cent level). Table 13.3 shows their frequency distribution by employment size, three-digit sector of activity and province.

Since these variables are binary, we estimate two logistic regression models, one to explain FO and one for PO:7

\[
\Pr(FO_{iP} = 1|X_{iP}, SK_P) = \Lambda(X_{iP}'\beta_{FO} + SK_P\beta_{FO}) \tag{13.1}
\]

\[
\Pr(PO_{iP} = 1|X_{iP}, SK_P) = \Lambda(X_{iP}'\beta_{PO} + SK_P\beta_{PO}) \tag{13.2}
\]

where \(i\) denotes the firm and \(P\) denotes the province (NUTS-3 region) in which the firm is located.

Our regressors include a vector \(X\) of firm-level controls and a measure for local social capital \((SK)\). According to Abraham and Taylor (1996),

<table>
<thead>
<tr>
<th>Province (NUTS-3)</th>
<th>DINFRA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bologna</td>
<td>0.207</td>
</tr>
<tr>
<td>Ferrara</td>
<td>0.232</td>
</tr>
<tr>
<td>Forlì-Cesena</td>
<td>0.173</td>
</tr>
<tr>
<td>Modena</td>
<td>0.214</td>
</tr>
<tr>
<td>Parma</td>
<td>0.170</td>
</tr>
<tr>
<td>Piacenza</td>
<td>0.192</td>
</tr>
<tr>
<td>Ravenna</td>
<td>0.252</td>
</tr>
<tr>
<td>Reggio Emilia</td>
<td>0.192</td>
</tr>
<tr>
<td>Rimini</td>
<td>0.172</td>
</tr>
</tbody>
</table>
and other studies on the determinants of outsourcing (González et al., 2000; Mazzanti et al., 2009; Antonietti and Cainelli, 2008; Antonietti et al., 2014), three variables may affect the likelihood to outsource. The first is labour costs. It is acknowledged in the literature that one of the strongest motivations for externalizing activities is labour cost savings. Therefore we would expect high-wage firms to have a higher propensity to outsource their activities. However, if outsourcing occurs between similar firms, or follows a networking strategy rather than a search purely for lower wages, the effect of these costs can be insignificant for firms’ outsourcing behaviour (Taymaz and Kiliçaslan, 2005). Then we include (log) labour cost per employee (LC_EMP) as a first predictor.

The second variable is related to the need to deal with market uncertainty, and to smooth the workload of the regular workforce. Relying on the assumption that organizations prefer a steady flow of work, we would expect that firms facing higher uncertainty in output demand will

Table 13.3 Full and partial outsourcing: frequency distribution* by size, industry and province

<table>
<thead>
<tr>
<th>Employment class</th>
<th>FO</th>
<th>PO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–9</td>
<td>56.81</td>
<td>50.66</td>
</tr>
<tr>
<td>10–49</td>
<td>43.19</td>
<td>49.34</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry (3-digit)</th>
<th>FO</th>
<th>PO</th>
</tr>
</thead>
<tbody>
<tr>
<td>291</td>
<td>6.84</td>
<td>6.43</td>
</tr>
<tr>
<td>292</td>
<td>51.11</td>
<td>52.44</td>
</tr>
<tr>
<td>293</td>
<td>8.43</td>
<td>8.05</td>
</tr>
<tr>
<td>294</td>
<td>9.92</td>
<td>9.22</td>
</tr>
<tr>
<td>295</td>
<td>22.56</td>
<td>23.16</td>
</tr>
<tr>
<td>297</td>
<td>1.14</td>
<td>0.70</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Province</th>
<th>FO</th>
<th>PO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bologna</td>
<td>24.27</td>
<td>20.68</td>
</tr>
<tr>
<td>Ferrara</td>
<td>3.70</td>
<td>4.18</td>
</tr>
<tr>
<td>Forli-Cesena</td>
<td>5.81</td>
<td>6.12</td>
</tr>
<tr>
<td>Modena</td>
<td>19.94</td>
<td>21.92</td>
</tr>
<tr>
<td>Parma</td>
<td>16.24</td>
<td>15.96</td>
</tr>
<tr>
<td>Piacenza</td>
<td>5.24</td>
<td>5.19</td>
</tr>
<tr>
<td>Ravenna</td>
<td>5.58</td>
<td>5.89</td>
</tr>
<tr>
<td>Reggio Emilia</td>
<td>15.61</td>
<td>16.19</td>
</tr>
<tr>
<td>Rimini</td>
<td>3.61</td>
<td>3.87</td>
</tr>
</tbody>
</table>

Notes: * Values in cells report the size, industry and province distribution of observations with value 1 in FO and PO respectively.
be more likely to outsource their production or service activities than firms operating in more stable environments. Conversely, it might be that higher market uncertainty leads firms to integrate activities in order to minimize the risks and costs associated with re-contracting. In the absence of longitudinal data on output prices or sectoral turnover/employment dynamics, we measure demand uncertainty through a discrete variable (Local) taking the value of 1 if the firm operates in local domestic markets (used as the reference), 2 in its own region and 3 in more than three regions. In addition, we include a dummy equal to 1 if the firm exports goods (Export), and 0 otherwise (reference). The narrower the scale of the market, the lower should be the uncertainty of demand, since firms can monitor clients and customers more easily.

The third determinant is the availability of specialized suppliers. If there is a shortage of internal skills, and/or if scale economies can be achieved from external provision of specialized services, firms may find it more profitable to externalize their activities. We capture this effect through two variables: firm size, based on the idea that smaller firms are more likely to subcontract because they lack sufficient internal resources; and human capital. Employment size (Micro) is given by two dummy variables equal to 1 for firms employing 1 to 9 employees and 10 to 50 employees respectively (the latter is used as the reference). The level of human capital (HC) of the workforce is given by the share of white-collar job holders (i.e. managers, executives and clerks) in total firm employment.

Finally, other controls include:

- firm’s age (Age), computed as 2005 minus the firm’s start-up year;
- two continuous variables (share of turnover) measuring own production (Prod own) and production on behalf of a third party (Third party), to distinguish whether the firm is a supplier or not.

To control for unobserved heterogeneity, particularly in the form of firm- and industry-specific effects, we also include five three-digit industry dummies, and the 29 phase dummies (see note 7).

Local social capital is measured by a normalized index provided by Cartocci (2007), which borrows its key elements from Putnam et al. (1993). This index is obtained by pooling four elements through principal component analysis: (i) number of newspapers circulating per 1000 inhabitants (average between 2001 and 2002); (ii) proportion of the population participating in electoral turnouts per 100 voters (in years 1999–2001); (iii) average number of blood donations per 1000 inhabitants and blood donors per 1000 inhabitants (in 2002); and (iv) average number of sports
associations per 1000 inhabitants (in 1999) to number of sports memberships per 1000 inhabitants (in 2001). For all methodological details, see Cartocci (2007).

Therefore social capital is conceived here as a system of shared values and beliefs that should prevent or reduce opportunistic behaviour by favouring trust building and mutual cooperation among people.\(^8\) This chimes with the definition in Putnam et al. (1993), according to which social capital refers to features of social organizations, such as trust, norms and networks, that can improve the efficiency of society by facilitating coordinated actions.

Equations (13.1) and (13.2) are first estimated on the full sample of firms and then on four different groups, identified according to the values of our infrastructure variable, that is, DINFRA, as in Table 13.2. The classes of DINFRA used in order to identify the groups are: DINFRA\(\leq 0.18\) (Group 1 – Parma, Forlì-Cesena and Rimini), \(0.18 < \text{DINFRA} \leq 0.2\) (Group 2 – Piacenza and Bologna), \(0.2 < \text{DINFRA} \leq 0.22\) (Group 3 – Modena and Reggio Emilia) and DINFRA > 0.22 (Group 4 – Ferrara and Ravenna). By splitting the sample into these four parts, we can observe how the effect of social capital varies with the density of local infrastructures. Therefore we can estimate four different coefficients of social capital, and compare them across different levels of infrastructure endowments.\(^9\)

Table 13.4 gives the main summary statistics for all the described variables, while Table 13.5 shows the correlation matrix among continuous variables, from which we exclude any \textit{a priori} problem of multicollinearity.

We also consider the issue of endogeneity. Since our data are cross-sectional, and although we measure social capital four years before outsourcing, potential simultaneity bias may affect our estimates. To the extent to which social capital is persistent over time,\(^10\) it may be that

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>17.44</td>
<td>10.84</td>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>Micro</td>
<td>0.707</td>
<td>0.455</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>HC</td>
<td>0.096</td>
<td>0.150</td>
<td>0</td>
<td>0.906</td>
</tr>
<tr>
<td>LC_EMP</td>
<td>0.125</td>
<td>0.134</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Local</td>
<td>1.831</td>
<td>0.910</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Global</td>
<td>0.376</td>
<td>0.484</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Prod own</td>
<td>0.325</td>
<td>0.419</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Third party</td>
<td>0.359</td>
<td>0.442</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>SK</td>
<td>4.531</td>
<td>0.899</td>
<td>2.53</td>
<td>5.47</td>
</tr>
</tbody>
</table>
higher social capital is the result of a higher propensity to outsource in that province. To test for this, we use the Smith and Blundell (1986) test of exogeneity. Relying on Putnam et al.’s (1993) idea that social capital is the outcome of historical experience, we use as instrument the number of years in which Emilia Romagna provinces were independent of past foreign dominations in the 700 years before the creation of a unified Italian state, that is, between 1100 and 1800 (Di Liberto and Sideri, 2011). Table 13.6 shows the number of years of independence for each province of Emilia Romagna during the period considered.

The intuition behind this is that the type of foreign domination will have shaped the cultural and entrepreneurial context of these regions, favouring a process of social capital accumulation over time. In particular, Putnam

### Table 13.5  Correlation matrix among continuous variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Age</th>
<th>HC</th>
<th>LC_EMP</th>
<th>Prod own</th>
<th>Third part</th>
<th>SK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HC</td>
<td>0.13*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LC_EMP</td>
<td>0.18*</td>
<td>0.56*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prod own</td>
<td>0.19*</td>
<td>0.34*</td>
<td>0.33*</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third party</td>
<td>−0.05*</td>
<td>−0.14*</td>
<td>−0.08*</td>
<td>−0.54*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SK</td>
<td>0.02</td>
<td>0.04**</td>
<td>0.03**</td>
<td>−0.02</td>
<td>0.07*</td>
<td>1</td>
</tr>
</tbody>
</table>

**Notes:** * Significant at 1%; ** significant at 5%.

### Table 13.6  Years of independence from past dominations in Emilia Romagna, 1100–1800

<table>
<thead>
<tr>
<th>Province</th>
<th>Number of years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bologna</td>
<td>406</td>
</tr>
<tr>
<td>Ferrara</td>
<td>498</td>
</tr>
<tr>
<td>Forlì-Cesena</td>
<td>341</td>
</tr>
<tr>
<td>Modena</td>
<td>700</td>
</tr>
<tr>
<td>Parma</td>
<td>631</td>
</tr>
<tr>
<td>Piacenza</td>
<td>631</td>
</tr>
<tr>
<td>Ravenna</td>
<td>341</td>
</tr>
<tr>
<td>Reggio Emilia</td>
<td>700</td>
</tr>
<tr>
<td>Rimini</td>
<td>341</td>
</tr>
<tr>
<td>Mean</td>
<td>548</td>
</tr>
</tbody>
</table>

**Note:** Data are extracted from Di Liberto and Sideri (2011).
et al. (1993) argue that the lack of any formal authority characterizing independent regions (or free city-states) favoured the creation of social capital because of higher propensity (for individuals and firms) to cooperate (Guiso et al., 2004). Our identification strategy is that, other things being equal, years of independence from past domination influence outsourcing behaviour in 2005 only through their effect on local social capital accumulation.

4. RESULTS

Tables 13.7 and 13.8 present the estimates of the logistic regression models for FO and PO respectively. In both of them, Column 1 reports the marginal effects of the logit model when estimated on the full sample, whereas Columns 2, 3, 4 and 5 refer to firms located in provinces belonging, respectively, to the four groups based on DINFRA classes.

Table 13.7, Column 1, shows that the propensity for FO production activities is higher for micro firms (1–9 employees) when unit labour cost is higher and when the geographic scope of the market is narrower. These results are in line with previous literature (Abraham and Taylor, 1996; González-Díaz et al., 2000): outsourcing is more frequent when labour costs are higher, demand uncertainty is lower and when the firm presumably lacks in-house specialized skills (as reflected by the positive coefficient of the Micro dummy). In addition, producing on its own stimulates FO more than working on behalf of third parties. As expected, the impact of local social capital is positive and highly statistically significant: firms located in highly trustworthy contexts tend to fully outsource more than firms located elsewhere.12

Columns 2 to 5 show that the impact of social capital on FO holds positive, and becomes even stronger as the density of local infrastructures increases: the lowest marginal effect is registered in Group 1, while the highest effect is found in Group 4 of the DINFRA index. Moreover, the tests of equality of coefficients across equations show that all estimated coefficients are different from each other. In line with H1, we find that, when transport costs are lower, and mobility is easier, firms rely more on local trust for subcontracting their production activities to external suppliers.

Interestingly, we also find that, at lower infrastructure density, FO becomes significantly and negatively related to firm’s age, while the magnitude of the LC_EMP and Third party coefficients increases significantly. At the highest infrastructure density levels, instead, older firms tend to
### Table 13.7  Full outsourcing: estimated marginal effects

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>−0.013</td>
<td>−0.040***</td>
<td>−0.025***</td>
<td>0.009</td>
<td>0.054**</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.015)</td>
<td>(0.001)</td>
<td>(0.033)</td>
<td>(0.025)</td>
</tr>
<tr>
<td>Micro</td>
<td>0.088***</td>
<td>0.125***</td>
<td>0.109***</td>
<td>0.033</td>
<td>0.037</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.038)</td>
<td>(0.010)</td>
<td>(0.024)</td>
<td>(0.053)</td>
</tr>
<tr>
<td>HC</td>
<td>0.002</td>
<td>−0.015</td>
<td>0.113***</td>
<td>−0.065</td>
<td>−0.321</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td>(0.030)</td>
<td>(0.037)</td>
<td>(0.081)</td>
<td>(0.233)</td>
</tr>
<tr>
<td>LC_EMP</td>
<td>0.029***</td>
<td>0.056**</td>
<td>0.004</td>
<td>0.034</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.022)</td>
<td>(0.019)</td>
<td>(0.031)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Local</td>
<td>−0.026*</td>
<td>−0.013</td>
<td>−0.012</td>
<td>−0.030</td>
<td>−0.178***</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.020)</td>
<td>(0.014)</td>
<td>(0.022)</td>
<td>(0.035)</td>
</tr>
<tr>
<td>Export</td>
<td>0.009</td>
<td>0.025</td>
<td>0.023</td>
<td>0.005</td>
<td>0.060</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td>(0.067)</td>
<td>(0.052)</td>
<td>(0.049)</td>
<td>(0.278)</td>
</tr>
<tr>
<td>Prod own</td>
<td>0.199***</td>
<td>0.229***</td>
<td>0.204***</td>
<td>0.034</td>
<td>0.107*</td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>(0.040)</td>
<td>(0.051)</td>
<td>(0.080)</td>
<td>(0.056)</td>
</tr>
<tr>
<td>Third party</td>
<td>0.078*</td>
<td>0.196***</td>
<td>0.151***</td>
<td>−0.013</td>
<td>−0.697***</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.047)</td>
<td>(0.012)</td>
<td>(0.051)</td>
<td>(0.193)</td>
</tr>
<tr>
<td>SK</td>
<td>0.020***</td>
<td>0.020***</td>
<td>0.031***</td>
<td>0.047**</td>
<td>0.170***</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.001)</td>
<td>(0.013)</td>
<td>(0.052)</td>
</tr>
<tr>
<td>Industry dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Phase dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>3280</td>
<td>852</td>
<td>937</td>
<td>1103</td>
<td>366</td>
</tr>
<tr>
<td>Pseudo R²</td>
<td>0.476</td>
<td>0.418</td>
<td>0.539</td>
<td>0.527</td>
<td>0.615</td>
</tr>
<tr>
<td>Corr. class. (%)</td>
<td>84.42</td>
<td>82.63</td>
<td>86.55</td>
<td>86.22</td>
<td>90.44</td>
</tr>
<tr>
<td>Smith–Blundell test (p-value)</td>
<td>0.501</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Test of equality of coefficients across equations**


**Notes:** Cluster-robust (at province level) standard errors are reported in parentheses. *** Significant at 1%; ** significant at 5%; * significant at 10%. Cells report marginal effects at the mean of continuous variables and for discrete change of dummy variables from 0 to 1. All the estimates also include a constant term.
outsource more; the local scope of the market and working on behalf of third parties become relevant barriers to FO.

Moreover, in Column 1 the Smith and Blundell test does not reject the null hypothesis of exogeneity of social capital.

For the PO case, Table 13.8 Column 1 shows a different picture. The decision to partly outsource production is positively related to firm’s age, size and unit labour cost, while it is negatively related to the geographical scope of the final market, and to producing on its own. As expected, the coefficient of social capital is not statistically significant, and Columns 2 to 5 confirm that this holds for whatever density of transport infrastructures.
Therefore these results confirm H2: when monitoring capability is higher, firms do not need social capital for contracting out their activities, and this holds regardless of the local endowment of transport infrastructures.

As a further robustness check, we also re-estimate equations (13.1) and (13.2) using different measures of social capital. In particular, we make use of two indices of ‘negative’ social capital, which should capture the propensity of local economic agents to behave opportunistically and fraudulently. The first is the Mafia index, computed by Calderoni (2011), which is the normalized mean of four relevant dimensions of the presence of mafia in a territory: the existence of mafia-type associations, mafia-related murders, city councils dissolved by mafia infiltration and assets confiscated from organized crime. These variables are computed over the period 1983–2008. The second is the Opportunism index, developed by Arrighetti et al. (2003), which corresponds to a standardized index of the number of official complaints concerning promissory notes and banking cheques plus the number of rejected bills per 1000 inhabitants in 1996, and the number of crimes against the national heritage, economy, industry and trades (which resulted in a formal court case) per 1000 inhabitants in 1996. For both of them, the higher the index, the higher is the propensity of local economic agents to behave opportunistically.

We should expect the likelihood to fully externalize production to be lower in areas where the attitude to cheat is higher. In line with H1, the negative correlation between opportunism and FO should be stronger in areas where the density of transport infrastructures is lower, as the monitoring of suppliers and the governance of transactions is more difficult and costly. In line with H2, we should expect PO to be independent of the level of local opportunism, regardless of the infrastructure endowment of the region.

Table 13.9 shows the estimation results where the Mafia index and the Opportunism index are used to replace $SK$. For reasons of space, we do not report the estimated coefficients of all the other firm-level controls, which maintain their sign and statistical significance. When considering the full sample (Column 1), we find that an increase in the local propensity for illicit behaviour is related to a lower likelihood to fully outsource production, whereas we do not find any statistically significant result for the Mafia index. When we split the sample into infrastructure density groups (Columns 2 to 5), we find a negative correlation between FO and both the Mafia index and the Opportunism index: this negative relation is stronger at lower levels of DINFRA, and it vanishes in provinces with the highest endowments of transport infrastructures. For the PO case, we find no statistically significant coefficient for either the Mafia index or the Opportunism index. We conclude that our previous results based on $SK$
are robust to alternative measures of social capital, which means that H1 and H2 are still confirmed.

5. CONCLUSIONS

Relying on a rich firm-level dataset of machine-tool firms located in Emilia Romagna, Italy, we analysed the relationship between social capital and the propensity of firms to outsource production activities. Unlike previous studies, we also control whether such a relationship depends on the level of local infrastructure endowment, which affects transport costs and accessibility, and on monitoring costs, which are reflected in the type of outsourcing strategy adopted, that is, full versus partial outsourcing.

We find that social capital positively affects the choice to fully outsource production activities. As expected, we also find that such a positive effect materializes in provinces with a high density of transport infrastructures, whereas no effect is registered in provinces with a low infrastructure density. On the other hand, the propensity to partially outsource is not affected by social capital, independently of the local level of infrastructure endowment. We argue that this occurs because the firm maintains control over the production process, thus lowering the need for a trustworthy environment for reducing the risk of opportunistic behaviour. These results are robust to the inclusion of firm-specific controls, endogeneity and use of alternative measures of social capital.

Table 13.9  Effects of the Mafia index and the Opportunism index on FO and PO: marginal effects

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mafia index</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FO</td>
<td>0.004</td>
<td>−0.171***</td>
<td>−0.138***</td>
<td>−0.043***</td>
<td>−5.383</td>
</tr>
<tr>
<td></td>
<td>(0.057)</td>
<td>(0.052)</td>
<td>(0.018)</td>
<td>(0.019)</td>
<td>(4.197)</td>
</tr>
<tr>
<td>PO</td>
<td>0.012</td>
<td>0.072</td>
<td>0.039</td>
<td>0.041</td>
<td>1.200</td>
</tr>
<tr>
<td></td>
<td>(0.057)</td>
<td>(0.094)</td>
<td>(0.034)</td>
<td>(0.113)</td>
<td>(1.290)</td>
</tr>
<tr>
<td>Opportunism index</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FO</td>
<td>−0.173**</td>
<td>−0.260***</td>
<td>−0.135***</td>
<td>−0.063***</td>
<td>−1.233</td>
</tr>
<tr>
<td></td>
<td>(0.077)</td>
<td>(0.080)</td>
<td>(0.018)</td>
<td>(0.028)</td>
<td>(0.961)</td>
</tr>
<tr>
<td>PO</td>
<td>0.104</td>
<td>0.109</td>
<td>0.039</td>
<td>0.060</td>
<td>0.275</td>
</tr>
<tr>
<td></td>
<td>(0.070)</td>
<td>(0.144)</td>
<td>(0.132)</td>
<td>(0.218)</td>
<td>(0.534)</td>
</tr>
</tbody>
</table>
From a policy perspective, our results, although limited to small firms and to the case of Emilia Romagna, could be useful for designing an environment that would spur the local division of labour across firms and production phases. In this respect, we stress the importance of social capital and infrastructures as complementary assets in building trust among neighbouring firms.

As remarked by Westlund and Adam (2010), a potential caveat may be that Italy, and Emilia Romagna in particular, represents a ‘special case’, where the positive relation between social capital and economic performance is always found positive and significant. In this case, comparative studies on other countries or regions could provide a further robustness test of our results.

NOTES

1. Social capital has been proposed as one of the key elements in explaining several phenomena, such as economic growth (Zak and Knack, 2001), financial development (Guiso et al., 2004), innovation (Akçomak and ter Weel, 2009; Crescenzi et al., 2013), crime (Glaeser et al., 1995), education (Coleman, 1988; OECD, 2001), and regional development (De Blasio and Nuzzo, 2009; Tabellini, 2010). For a critical review of the empirical results on social capital see Durlauf (2002), Durlauf and Fafchamps (2005) and Westlund and Adam (2010).

2. For a survey on the economic role of infrastructures, see Melo et al. (2013). Transport infrastructure also has a positive impact on local development as it enhances the agglomeration economies of a territory (Egger and Falkinger, 2003; Venables, 2007). The economic role of infrastructure has been tested in different contexts, but results remain ambiguous. Some studies find a positive effect of transport infrastructures on local economic growth (e.g. Graham, 2007; Bronzini and Piselli, 2009), whereas others find negative effects (e.g. Crescenzi and Rodríguez-Pose, 2012).

3. Since beyond this threshold the universe of firms is not fully represented, we preferred to focus only on firms with fewer than 50 employees. In this way, we provide a more accurate picture of the regional manufacturing industry.

4. We thank Anna Montini for providing the ready-to-use data.

5. The questionnaire reports 29 product transformation phases specific to the machine-tool industry: design, sintering, hot-working, cold-working, working with swarf, gear working, refining, thermal treatments, surface treatments, assembling by welding, assembling by sticking, assembling by riveting, mechanical assembling, electrical assembling, control software development, rubber and plastics working, glass working, wood working, testing, packing, washing, sand-blasting, painting, installing, repairing and ordinary maintenance, repairing and scheduled maintenance, general overhaul, component replacement, component re-working. For more details see Antonietti et al. (2014).

6. We also estimated equations (13.1) and (13.2) in a bivariate probit model. Since the $\rho$ coefficient, which represents the covariance between the error components of the FO and PO equations, is not statistically significant, we use two separate univariate probit models, which also allow an easier treatment of endogeneity.

7. This definition is similar to the one proposed by Guiso et al. (2008) of a set of beliefs and values that facilitate cooperation among the members of a community, and overlaps...
with the definition in Guiso et al. (2011, p. 419) of the concept of civic capital, defined as ‘persistent and shared values that help a group overcome the free rider problem in the pursuit of socially valuable activities’.

9. Since we are estimating logistic models, we prefer to avoid the use of interaction terms.
10. The persistence of social capital might be the result of an inter-temporal transmission of culture and values from parents to children, as modelled by Tabellini (2010).
11. According to Westlund and Adam (2010, p. 898), ‘trust does not fall down from the sky. It is a result of history, of previous interactions among actors and promoted by a common culture’.
12. This result is in line with recent evidence provided by Burker and Minerva (2014) on Italian manufacturing: in areas where social capital is higher, the average size of plants is found to be smaller.
13. Although FO and PO are measured in 2005, the presence of mafia is supposed to be a persistent phenomenon, so that we can assume that the Mafia index for years 2006–08 is not different from that for years 1983–2004. We consider the Mafia index as a measure of negative social capital: the presence of mafia is supposed to be higher in areas where the level of social capital and trust is lower, where opportunism is higher and where propensity for illicit behaviour is stronger. As a proof of this, the pairwise correlation with the previous measure of social capital SK is –0.167 and significant at the 1 per cent level.

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Index

Aker Verdal 125–6
practices of 130–31
Valhall 125–7
Amazon.com 211
American Community Survey (2007–11) 188, 191
Apple, Inc. 71
Arcview GIS software 314
Asset Alternatives 72, 74
Corporate Venturing Directory and Yearbook 71
Boston Consultancy Group (BCG) 261, 267, 271
Bureau of Economic Analysis (BEA) 216
business cycles 13, 163, 171, 251
new firm formation in 172
regional start-up rates of 178
Cambodia 267
Canada 125, 191
capital 117
access to 187
accumulation of 282
creative 13
financial 214, 220, 230
flows of 3
human 13, 141, 143, 150, 158, 213, 275, 294, 300
role in long-run economic growth 210
spillover 142
stock 210
physical 274, 294, 300
social 311–12, 314, 325–6
coefficients of 319, 323
definitions of 319
measures of 312–13, 319–20, 324
negative 324
venture 214
Carnegie Mellon University 72
Caterpillar 275
China, People's Republic of 2, 99, 191, 261, 267
IPR laws in 268
manufacturing sector of 269–70
CNRS 59
Colombia 191
Compustat 71–3, 75
Cox models
covariates of 33
hazard ratios of 35
proportional hazard 30
Craigslist 211
creativity 141–3
creative class 142–3, 155, 158–9
filter 13
influence of large urban spaces on 5–6
spillover 143, 158
models of 147–50, 154–5
credit
access to 187
Cuba 191
Decennial Census (2000) 188
Dell Computers 212
Denmark 188, 266
eBay 211
efficiency estimation 82
formulation of 73
emerging economies 264, 266–8, 276
creativity spillover of 143, 158
models of 147–50, 154
culture 165, 168, 170, 179–80
localized 171
regional 163–70
definitions of 188–9
high-tech 13, 192–4, 197
immigrant 184–7, 194, 200, 203
agglomeration patterns 185
enclaves 201
location choice 187–91
in cities 141–2
low barriers to entry 144
influence of large urban spaces on 5–7
international 89
knowledge spillovers of 142–3, 244
learning 169
overconfidence 237–8, 240–43, 247–8, 251–2
clustering bias 250–51
in networks 247
industrial level 244–5
social level 245–6
policies 10
regional 13, 180
role in long-run economic growth 210
role models 169
spatial clustering 185–6
entrepreneurship motor 2
European Community Innovation Surveys (CIS) 49
European Economic Area (EEA) 149, 154
European Patent Office (EPO) 51
PATSTAT database 51
European Union (EU) 2, 28, 144, 155
member states of 22, 25, 49
triadic protection in 22
European Urban Audit Surveys (UAS) 145
Eurostat
local administrative unit (LAU) 145, 149
evolutionary economics
development of 238–9
evolutionary theory 240, 249–50
Darwinian 238
influence of agents in 239–40
role of routines in 239
FedEx 212
foreign direct investment (FDI) 2, 8, 264–5
in manufacturing sector 276
outward 8
Foxconn 268
France 22, 24, 59
manufacturing sector of 281
Frontline Systems
Premium Solver 73
full-information maximum likelihood (FIML)
estimator 291
General Agreement on Tariffs and Trade (GATT) 2
General Electric 261
general purpose technologies (GPTs)
concept of 211
ICT as 211
generalized least squares (GLS)
estimation 154
regression 76
Germany 22, 59, 64, 191
Fall of Berlin Wall (1989) 2
start-up rates in 171
globalization 1–4, 10–11
Gómez Uranga, M. 28, 38
Google, Inc. 211
Heckman selection model 291
Herfindahl–Hirschman Index (HHI) 193–4
Honda Motor Co., Ltd 268
India 99
industrial agglomeration
as GPTs 211
concept of 185–6
information and communication technology (ICT) 3, 118, 150, 154–5, 158, 211, 223, 251
manufacturing of products 149
information/communication infrastructure 210–11
infrastructure density (DINFRA) 314–15, 319, 321, 323–4
infrastructure endowment 310–11
output demand 317–18
production outsourcing 310–11, 317, 325
domestic 311
full (FO) 313, 316, 321, 323–4
international 311
partial (PO) 313, 316, 321, 323–4
transport 310, 323–4
costs 312–13
innovation 1–2, 8, 95–6, 118, 211
collaboration 112
effect on productivity 284–5
flow of 89
influence of large urban spaces on 5–6
input 291–2, 296, 301
national systems of 22
organizational 3, 286
output 282, 285–6, 288–93, 296, 298, 301
process 133
production function 291, 294
radical 8–9, 96
relationship with routines 133–4
university collaboration 44
intellectual property rights (IPR) 261–2
disputes 72, 74, 77
leakage 269
legislation 268
international new ventures (INVs) 89, 91, 93, 95–6, 100, 102, 105, 107, 110–12
variable 95
corporation 95
creation of firm-specific assets/
resources for 92
development of 92–5, 105–6
network collaboration of 93–4
dynamic capabilities 97–8
enterprise group membership 97, 100
innovation collaboration of 112
inter-organizational collaboration of 90–92, 95–6, 111
internationalization of 97–8
management of 110–12
managerial practices of 90
New 94
Old 94
operationalization of 98
start-up 105–7, 110
variables in 99–100, 102, 105
binary 102
internationalization 89, 93
of firms 90–91
of INVs 97–8
speed of 90
Internet 3, 32, 189
broadband 13, 227, 230
access to 212, 215, 217–18, 223, 225, 230–32
adoption of 212
entrepreneurship opportunities offered by 211–12
Iran 191
ISI Web of Science
Science Citation Index Expanded (SCI-EXPANDED) 64
Italian Fiscal Authority
Sector Studies 314
Italian Statistical Institute (ISTAT) 314
Italy 311
Emilia Romagna 310–11, 314–15, 320, 325–6
Japan 22, 24
knowledge economy 9, 135, 263, 272
development of 136
emergence of 3
technology production in 135
knowledge spillover 22–3, 27, 81–2, 186, 204, 214, 243, 246
impact on agglomeration economies 185
interregional 7
intraregional 6
of entrepreneurship 142–3, 244
regional 5
knowledge transfer 65–6, 126, 132, 185, 311
from PRO 45
process of 124
regional branching based on 311
knowledge stickiness 65
Koenigsegg 270
labor
disputes 73
dispute of 120
force 190, 197, 203
immigrant 199, 201–3
self-employed 191, 201–2
Innovation and entrepreneurship in the global economy

market 188
demand 190
pooling 185
supply of 165
less developed countries (LDCs) 261, 263, 266
business milieu 268–9
labor practices in 267
manufacturing in 266–8, 270
offshoring 272, 275
supply chain 277
wage/cost advantages 270–71
LexisNexis Academic database 72
Likert scale 50

macroeconomics 1, 26, 188, 237
manufacturing 2, 7, 12, 26–8, 38, 46, 49, 125, 149–50, 154–5, 173, 175, 186, 190, 223, 232, 264, 266–7, 269–70, 281
3D printing 275
additive manufacturing (AM) 270–71
clustering of firms 185
cost of energy 271
economies of scale in 269–70
FDI in 276
high-tech 189
in LDCs 266–8
labor force in 202
machine 52
medicine/pharmaceutical 189
offshoring of 264, 266–7, 269–70, 272, 275
process 126–7
product development phase 272
re-shoring of 261–2, 264, 275–6
supply chain 277
Marshall–Arrow–Romer (MAR) model 6–7
Max Planck Institutes 64
Max Planck Society 59
Melting Pot Index 155
Metropolitan Statistical Areas (MSAs) 187–8, 201
broadband access in 212
high-tech immigrant entrepreneurs in 190, 194, 197, 199
Mexico 191, 267
Microsoft Corporation 67
Microsoft Excel 73
minimum effect scale (MES) 244
minimum performance inefficiency (MPI) technique 73
Missouri Census Data Center (MCDC) 215
multinational enterprises (MNEs) 275–6, 296
domestic 289, 296, 300
foreign 269, 289, 296–7, 300
multinational firms (MNFs) 3–4
National Statistics Institute (INE) 22
Netflix 211
Netherlands 266
new firm formation 216–18, 226–7, 231–2
factors influencing
cultural diversity 214–15
establishment size 213–14, 231–2
financial capital 214, 220, 230
government spending 214, 222
income growth 213
population growth 212–13
unemployment 213–14, 216
models of 217–18, 220
process of 215
role of broadband access in 212, 215, 217–18, 223, 225, 230–32
sectors 213, 215
accommodation 231
agriculture/forestry/fishing/hunting 223
finance/insurance/real estate 223, 225, 230–31
manufacturing 223
service 212, 231
new growth theory 210
North American Free Trade Agreement (NAFTA) 2
codes 189
four-digit 75
Norway 118
offshore oil sector of 125–6

Charlie Karlsson, Urban Gråsjö and Sofia Wixe - 9781783477319
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Index

ordinary least squares (OLS) 291, 294, 296, 300
estimation 76
regression 189
Organisation for Economic Co-operation and Development (OECD) 21–2, 24–5
patents 5–6, 12, 22–3, 46–7, 51–2, 56, 59, 70, 72–3, 77, 81, 184, 186–8, 190, 199–201, 210, 286
as measurement of innovation output 285–6
generation of 5
propensity 74
protection 69
technology-related 125
triadic 22
Philippines 191
Poisson regression 105
zero-inflated (ZIP) 107
Polanyi, Karl 121
Portugal
manufacturing sector of 26
Priceline 211
principal component analysis (PCA) 150, 154, 15
product life cycle (PLC) model 262, 272, 274
critiques of 263
extended 272, 274
first phase 262
fourth phase 271, 274–5
second phase 262–3
third phase 263
productivity 14, 24–6, 33, 66, 69, 72, 83, 118, 133–6, 185, 211, 214, 267, 271, 281, 286, 288–90, 298–9, 301
enhanced 123, 126
equation 292–4, 296–8
exporting 283–4
barriers 283
R&D in 284
heterogeneity 281, 300
innovation effect on 284–5
of exports 300
of routines 131
regional 155
securing of 68
technological 81
profit maximization 120
public research institutes (PRIs) 44–8, 52, 58–60, 64
as category of PRO 50
collaboration with universities 55, 58, 60
domestic 50
foreign 50, 59
interaction with 48–9
personnel of 48
public financing of 44
support for firms in R&D 45–7
public research organization (PRO) 44–5, 48, 50–52, 56–9
categories of 55
PRIs 50, 60
universities 50
knowledge transfer from 45
Public Use Microdata Samples (PUMS) 188–9
purchasing power parity (PPP) 149
qualitative analysis 250
quantitative analysis 250
research and development (R&D) 3–4, 12, 21–2, 24–8, 36–8, 45–6, 51–2, 56, 58–9, 68, 74, 96, 99, 181, 281, 285, 289–90
advanced 51
applied 45, 58
early-stage 48
effect on firm survival 31, 35, 37–8
expenditure 12, 21–2, 24–8, 31, 35
domestic 23
in productivity exporting 284
intensity 52, 54
investment in 10–11, 25, 27, 32, 35, 37, 282, 284–5, 287
private 24
late-stage 48
outsourcing 8–9
personnel of 49
private 9, 45
public sector 25, 45–6
ratio 35, 37
resources 38
returns 27
routines 117–18, 123, 127–8, 130–33, 135–6
Charlie Karlsson, Urban Gråsjö and Sofia Wixe - 9781783477319
Downloaded from Elgar Online at 08/08/2018 11:08:53AM
via Hungarian Academy of Sciences
Innovation and entrepreneurship in the global economy

as phenomenon 118
complexity 128
concept of 118–19, 121–2
context of 124
creation of 120
path dependency 124–5
relationship with innovation 133–4
process innovation 133–4
repetition in 122
stability of 122
use in management 123

Samsung 71
Schumpeter, Joseph 118–19, 144
SDC Platinum 72, 74
VentureXpert 71
Second World War (1939–45) 187
self-employment 186, 188–9
rates of 191
SEPI Foundation
Encuesta Sobre Estrategias Empresariales (ESEE)
Silicon Valley 162–3
immigrant-run high-technology firms in 184, 186–7, 197
South Korea 261
Soviet Union (USSR)
collapse of (1991) 2
Spain 22–3, 25–8
Basque Country 33
Cataluña 32–3
economy of 22–3, 38
La Rioja 33
Madrid 32–3
manufacturing sector of 12, 28, 37
Navarra 32–3
Pais Vasco 32–3
Spearman rank correlation coefficients 178
Standard Industrial Classification (SIC)
codes 189
start-ups 250
activity over business cycle 171–2, 178
INVs 105–7, 110
necessity-based 172–3
opportunity-based 172–3, 177
regional rates of 170–72
spatial distribution of 176–7
technological 74, 82
Statistics Sweden 51
strategic technology alliances 65
equity-based partnerships 71
short-term view of 70
Survey of Business Owners (SBO)
188–9
Survey of Current Business 264, 276
Sweden 13, 52, 64, 90, 98–9, 164, 170–71, 180, 266
Community Innovation Survey (CIS) 90, 98–100, 110, 282, 293–4, 301
economic crisis (1990s) 173, 175
engineering sector of 46, 58
INVs in operationalization of 98–9
Gnosjö-spirit 162–3
manufacturing sector of 12, 46, 49, 58
MNEs in 296
start-ups in 170–72
rates of 172, 177
spatial distribution of 176–7
Taiwan 261
technological advancement 69–71, 77, 81
concept of 67
industry appropriability regimes 69
of corporations 74
rates of 12, 77, 82–3
speed of 67–8
technological imitation 66–8, 70
opportunities 72
variables 73–4
technological startups 74, 82
telecommunications 32, 189
infrastructure 210–11
three-stage least squares (3SLS) 288, 294, 300
estimator 290, 292, 297
total factor productivity 66, 72
growth rates of 69
impact of innovation output on 298
transition probability analysis
concept of 170
two-stage least squares (2SLS) 292
Index

United Auto Workers Union (UAW) 269
United Kingdom (UK) 22
manufacturing sector of 27
United States of America (USA) 2, 13–14, 22, 24–5, 47, 99, 186–8, 191, 262–3, 272
Atlanta, GA 194
Boston, MA
Route 128 162, 187
Chicago, IL 194
Department of Agriculture (DEA) 216
Federal Communications
Commission (FCC) 215
Fort Lauderdale, TX 194
Houston, TX 194
immigration waves to 201
Los Angeles, CA 194
manufacturing sector of 223, 264, 266, 275–6
Miami, FL 197
New York 194
Research Triangle Park 187
Riverside, CA 197
San Francisco, CA 184, 194
Washington DC 197
Zip Code Tabulation Area (ZCTA) 212, 215, 232
universities 44–5, 47, 64
as category of PRO 50
collaboration in innovation 44
collaboration with PRIs 55, 58, 60
interaction within 49
support for firms in R&D 45–7
University of Bologna 314
UPS 212
urban economics 204
agglomeration benefits 184–5
US Census Bureau 75, 215–16
Vietnam 191
Warsaw Pact
collapse of (1991) 2
World Trade Organization (WTO) 2
Yahoo! 211
Yale University 72
zero-inflated negative binomial (ZINB)
specification 100, 105, 107