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University Knowledge Spillovers & Regional Start-up Rates: Supply and Demand Side Factors *

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Abstract: This paper investigates regional start-up rates in the knowledge intensive services and high-tech industries. Integrating insights from economic geography and population ecology into the literature on entrepreneurship, we develop a theoretical framework which captures how both supply- and demand-side factors mold the regional bedrock for start-ups in knowledge intensive industries. Using multi-level data of all knowledge intensive start-ups across 286 Swedish municipalities between 1994 and 2002 we demonstrate how characteristics of the economic and political milieu within each region influence the ratio of firm births. We find that economically affluent regions dominate entrepreneurial activity in terms of firm births, yet a number of much smaller rural regions also revealed high levels of start-ups. Knowledge spillovers from universities and firm R&D strongly affect the start-up rates for both knowledge intensive manufacturing and knowledge intensive services firms. However, the start-up rate of knowledge-intensive service firms is tied more strongly to the supply of highly educated individuals and the political regulatory regime within the municipality. This suggests that knowledge intensive service-start-ups are more susceptible to both demand-side and supply-side context than manufacturing start-ups. Our study contributes to the growing stream of research that explains entrepreneurial activity as shaped by contextual factors, most notably educational institutions that contribute to technology start-ups.

INTRODUCTION

A substantial literature in entrepreneurship (Acs & Varga, 2005), population ecology (Lomi, 1995), and economic geography (Rocha, 2004) suggests that geographic factors are important in shaping the emergence of new entrepreneurial firms (Sorensen & Audia 2000; Sørensen & Sorensen, 2003). Macro-oriented research in population ecology and economic geography indicates significant differences in, for example, entrepreneurial start-up rates across regions and countries as well as between industries. The explanations vary from advantages of industrial clustering (Malmberg & Maskell, 1999), labour market characteristics, for example, flows and access to knowledge (Lorenzen & Frederiksen, 2008) and institutional thickness (Amin & Thrift, 1995)[1], to location based opportunities founded on localized learning (Malmberg & Maskell, 1999) and natural resource endowments such as climate or raw materials (Ellison & Glaeser, 1999). Micro-oriented entrepreneurship research on the other hand demonstrates how resources and initial conditions present at the time of founding can influence new firms in long lasting ways, even if more resources are accumulated and environmental conditions change (Delmar, Hellerstedt, & Wennberg, 2006; Dahl & Sorensen, 2008). Fundamental to this line of argument is the assumption that resource endowments, economic conditions, and institutional conditions present during the founding process influences the firm's development even though the environment and the firm will continue to change (Eisenhardt & Schoonhoven, 1990). Such resources tend to be strongly linked to particular regions (Gianetti & Simonov, 2007). Thus, of particular interest is the role of geography in the creation and evolution of new firms.

[1] Institutional thickness refers to the totality of social, cultural, and institutional forms and supports available to enterprises. This includes trade associations, universities, voluntary agencies, sectoral coalitions, concrete institutions, and local elites—their effects on local policy, and their consensus institutions: common agreements, shared views and interpretations, and unwritten laws.

Summarizing the two research orientations Feldman (2001) highlights that entrepreneurship is more than an individual act and it is therefore equally necessary to understand entrepreneurship as a ‘regional event’. We elaborate on this view by posing the question: *To what extend does localized knowledge spillovers affect the rate of start-up in various regions?* Our study revolves around how characteristics of the economic milieu of regions influence the births rate of new firms (Wagner & Sternberg, 2004). In particular, we explore the impact of human capital and knowledge spillovers from universities on regional start-up rates, controlling for an array of economic and institutional factors.

We utilize a unique data set, which contains information on all knowledge intensive start-ups across the 286 Swedish municipalities between 1994 and 2002. Our theoretical framework aims to capture both supply- and demand-side factors, with a specific emphasis on the effect of the latter on entrepreneurial action. In doing so, we seek to complement the extant research that concentrate on the supply of entrepreneurial individuals in analyses of start-up rates (Thornton, 1999). The paper is structured as follows: First, we discuss the literature on regional variation and new firm formation. We zoom in on the importance of initial conditions at the founding stage as they are treated and explained in the literatures of organizational ecology and industrial organization. Key emphasis is given to arguments from the literature on clusters and their effect on new firm births. A descriptive analysis describes the variation in start-up rates across regions in the settings we investigate. In the methods section we derive a number of theoretical variables from the literature review, and explain how these are modelled in separate analyses of the regional start-up rates among knowledge-intensive services and high-tech manufacturing firms. We conclude by discussing our findings and their implications for theory and future research, as well as for regional public policy.

THEORY

A broad literature points to the importance of the initial conditions and resources available at the time of founding for firm evolution (Kimberly, 1979; Aldrich & Ruef, 2006). We draw on arguments from the literatures of population ecology, industrial organization economics and entrepreneurship research to theorize about these patterns. Our theoretical framework of how knowledge spillovers affect start-up rates in regions takes inspiration from Helfat's (2009) notion that *"...papers waste a lot of ink on what may be premature hypotheses. To put it bluntly, the current state of affairs where researchers feel they have to come up with hypotheses in order to justify empirical work is counterproductive"* (Helfat, 2009:188). Consequently, we develop below a broad theoretical framework that points us towards a set of particularly interesting explanations to be empirically explored rather than aim to build a narrow set of testable hypotheses.

Sociological perspectives on knowledge spillovers and start-up rates

The logic behind the role of initial conditions for start-ups has been theorized by the macrosociological ecological theories of *density delay* and *red queen competition.* Density delay proposes that the number of competitors present at the time of firms' founding reduces the amount of resources for each firm, lowering the rate of local start-ups and also increasing the probability of exit throughout their entire life course because the lower resource available in periods of high density tend to become self-reinforcing (Carroll & Hannan, 1989). The theory of red queen competition, on the other hand, suggests that the number of competitors present at the time of firms' founding can increase the viability of firms that manage to remain in business (Barnett & Pontikes, 2008). Hence, density delay stresses *selection-based competition* whereas red queen competition stresses *adaptation from competition*. Both theories originate from the model of density-dependence in population ecology that investigates the dynamics of organizational entry, growth and exit from a macro sociological lens. In this line of research, organizational *density* is measured by the number of firms in a population, which include all firms with similar structural attributes (organizational form) but differ from the economic notion of industry (Boone & van Witteloostuijn, 1995). The equilibrium number of firms according to the density dependency model is called the *carrying capacity* which refers to the numbers of a specific organizational form that can be sustained in a particular environment in isolation from other populations (Hannan & Carroll, 1992, p. 29). When the actual number of firms in a market is larger than the carrying capacity, firms that are ill adapted will exit due to external pressure. If the actual number of firms is smaller than the carrying capacity, this implies room for entry.

Economic perspectives on knowledge spillovers and start-up rates

Work in industrial organization economics and economic geography highlights the importance of initial conditions for new firm's evolution. The 'revolving door' theory presented by Audretsch (1995) explain the fact that entry and exit rates are higher in economic booms, indicating that the average quality of start-ups increases and inefficient firms are closed when their founders exit and move on to other activities, as labor market conditions are fertile. These patterns are also shaped by the life cycle of different industries, as economic downturns lead to accentuated decline in mature industries (Freeman & Perez, 1988), such as is the case with the automobile industry during the world-wide financial crisis in 2008. Key features of the life cycle theories are: young industries are dominated by a few early entrants who tend to demand high prices for their products. Often times these firms are geographically clustered (Klepper, 1997). This spurs the entry of more firms with increasingly higher output and lower prices. As the rate of growth in combined output falls below the average growth rate of individual firms, many firms are forced to exit – causing a "shakeout" in the industry (Klepper & Graddy, 1990; Jovanovic & MacDonald, 1994). While most industries go through a product life cycle that captures the way many industries evolve through their early years, when they reach maturity, the industry's further development tends to be difficult to predict with the life cycle approach (Klepper, 1997).

The life cycle model suggests that there are benefits to achieve from starting during early stages in an industry's development path as this provides new firms the time to develop capabilities that may lower risk of failure during a shakeout, similar to the density delay model in population ecology. However, research in economic geography advocates for a more fine-grained model. Here entry of new firms in regions already characterized by many firms feeds into a self-reinforcing process that drives agglomeration of related firms, cooperating and competing with each other (Feldman, Francis, & Bercovitz, 2005). Thus, influence from agglomeration effects offers a more micro-oriented model of how environmental conditions shape firm births and evolution than the macro oriented models in population ecology and industrial organization life cycle analysis.

To explicate how our theoretical pillars of population ecology, industrial organization economics and entrepreneurship are commensurable with each other, it is important to first note that, for example, the density dependency's model of the time trajectory of number of firms in a population clearly resembles the notion of the industry life cycle in industrial organization (van Wissen, 2004). However, the interpretation of competition in the population ecology view is not directly transferable into notions of agglomeration economies. The ecological process of competition is generally stated as "the negative effect of the presence of one or more actors on the life chances or growth rates of some focal actor" (Carroll & Hannan, 2000, p. 225). This view of competition basically states that given a fixed resource space (e.g. in a consumer market), competition rises geometrically with the number of firms in a population. This concept of competition does not assume the notion of profit maximization as the driving motivation for firms, or as in Cave's (1998, p.1947) words, ignoring "the need to cover costs to keep a firm's coalitions together". In organizational ecology, this role is rather taken by forces of natural selection and organizational inertia in adapting, for example, employment contracts to technological or market changes (Hannan, Burton & Baron, 1996). A final distinction between the entry models suggested by population ecology and industrial organization economics is that population ecology focuses both on economic (carrying capacity) and socio-cognitive barriers (legitimacy) whereas industrial organization economics is concerned with distinct economic barriers such as how concentrated an industry is, and whether there are other barriers to entry such as legal regulations and high set-up costs. Nevertheless, both agglomeration economics and population ecology are essential insights for our analysis of demand side effects on entrepreneurial processes. Hence, the empirical examinations herein strive to integrate the essential factors advocated by these theories.

A socio-economic perspective on knowledge spillovers and start-up rates

In economic geography, Marshall (1920) defined three broad forces leading to a geographic concentration of industries: labor market pooling, availability of intermediate inputs into production processes, and spillovers of knowledge between firms. All of these are supply-side forces, stimulating the entry of new firms into regions that have already accumulated many firms. Because supply-side sources are relatively immobile (Tassey, 1991) the entry of new firms in regions already characterized by existing agglomeration feeds into a self-reinforcing process that can amalgamate agglomerated industries into an economic cluster. The literature suggests that clusters might affect entrepreneurship in several ways:

- Cluster characteristics may reduce the barriers of entry for new firms (Sternberg & Litzenberger, 2004). Lower entry barriers might affect the cognitive perceptions of success and thus induce entrepreneur to risk taking the difficult step from being a potential founder to being a nascent entrepreneur (Sorenson & Audia, 2000).
- In agglomerations there is generally stronger job-matching opportunities and service economies of scale and scope (Gordon & McCann, 2000)
- Clusters are characterized by lower search costs which facilitate entrepreneurs' efforts of finding buyers, and to be found (Stuart, 1979). Agglomerated regions therefore offer greater communicational advantages as firms develop better knowledge of each other (Saxenian, 1985) over time and thus continuously decrease search costs over time.
- Clusters are characterized by lower transaction-costs, which can be seen as a variation of Marshall's specialization argument (Rocha, 2004). In an industrial agglomeration, the proximity of buyers reduces the transaction costs which arise from vertical disintegration.
- Lower exit barriers: Porter (1990) argues that under-performing entrepreneurs can more easily find alternative employment, and would be more likely to leave the industry. This leads to higher churn rates, but it also means that the average performance of the remaining firms increases.

A common and important definition of agglomerations and clusters is that they include *both competition and cooperation* among new or existing firms. Firms have industrially linked suppliers in a region that share between them tradable resources (Maskell & Malmberg, 1999), but they also share knowledge that is part and parcel of the social community, acting as a public good for many or all firms in the region. In many high-technology clusters, competitors have formed intricate networks of interdependencies (Porter, 1993). They share ties to a research base such as universities, skilled labor, highly qualified suppliers, and venture capitalists (Pouder & St. John, 1996). These interrelationships spur the initial formation of an economic cluster, and the very same relationships also contribute to holding the cluster together over time (McCann & Folta, 2008).

The competitive pressure that arises from agglomerations is likely to differ between firms of different sizes and with distinct market strategies. Studies in organizational ecology have addressed such differences for firms that are considered generalists – firms targeting several markets – and firms that are specialists – firms targeting a specific market niche (Swaminathan, 1996). This line of research suggests an evolutionary theory of resource partitioning, in which markets dominated by a small number of large generalists firms, smaller specialists enjoy greater relative opportunities and will therefore benefit more by co-locating than generalists (Carroll, 1985). Conversely, in markets dominated by many different specialized firms, competition between these firms for resources will be higher and therefore co-locating will be less beneficial. So, the proximity of similar firms might adversely affect the survival capabilities of these firms due to heightened competition, but only to the extent that that the agglomeration depends on a concentrated industry where large generalists and small specialists neighbouring firms have inter-linked demand structure, co-location will instead increase their performance (Barnett & Carroll, 1987; Porter, 1990). Resource partitioning theory might explain both why some clustered regions enhances the performance and survival of new entrepreneurial firms whereas other clusters decrease the performance of new firm, and how a cluster that is beneficial for new firms evolves into a cluster that is detrimental to their survival.

Before plunging deeper into analyses of birth rates in Swedish regions, we return shortly to our theoretical outline to motivate the choice of explanatory variables (i.e. firm birth rates). Both the density dependence model in population ecology and the concept of agglomeration economies in economic geography involve a form of positive feedback between size of the population and the entry and growth of firms (Boone & van Witteloostuijn, 1995; van Wissen, 2004). For example, the suggested mechanisms within ecological process of legitimization where an organization receives a “social taken-for-granted character” (Carroll & Hannan, 2000, p. 223) resembles in many respects the emergence of agglomeration economies in the ‘new economic geography’ research (Sorenson & Audia, 2000). Organization ecology suggests that the more firms that enter increase legitimation of the population since it is perceived as a viable way of organizing and producing an output, which is conceptually neighbouring the notion of *learning regions* and regional knowledge accumulation in the agglomeration literature (cf. van Wissen, 2004). A related sociological theory maintains that firm births are facilitated by socio-economic legitimacy (Baum & 1996) in that other societal constituents such as consumers, regulators, and suppliers have predetermined ideas of what constitute ‘proper’ modes of business activities and the coercive pressure from such constituents may hamper or facilitate the start-up activities of local firms. Some recent work provides support for this theory also in the Swedish context: Gianetti and Simonov (2007) examined self-employment entry in all Swedish municipalities between 1995 and 2000 and found that the type of past political leadership in a focal country exhibited strong influence on the level of entries. Hence, our analysis of demand side factors includes not only economic variables but also variables pertaining to the political situation in specific regions.

Both organizational ecology and agglomeration economics highlight factors related to localization economies: The size of the customer base, marketing, the size and quality of the labour pool, and a network of producers that share common knowledge and experience. And as van Wissen (2004) points out, the element of creating a social structure of an industry is similar to the defining features of a new cluster as an area-based on a common social and cultural background. A final similarity that has received little attention is that while some theories of agglomeration economies in principle assume no upper limit, recent work highlights the potential negative externalities of agglomeration in the form of ‘congestions cost’ (Arthur, 1990; Brezis & Krugman, 1997). These potentially non-linear effects of firm density are accentuated in population ecology where there is a natural upper ‘carrying capacity' after which the positive effects of density turns negative. Hence, it is important to allow for such non-linearities in analyzes of firm births and we therefore integrate explanatory variables from both population ecology and agglomeration economic research. The positive and negative benefits of firm agglomeration is believed to differ between services and industries, due to differences in sunk cost, barriers to entry, etc (Caves, 1988). Service firms enter the market with lower initial costs while manufacturing firms have higher-set up costs and different economies of scale (Geroski, 1995; Klepper & Graddy, 1990). As such, it is important to differentiate between services and industries in empirical investigations of agglomeration economics for new start-ups. Our empirical investigation thus contains separate analysis of knowledge intensive service-start-ups and knowledge intensive manufacturing start-ups.

METHODS

Research setting

The empirical setting for our test of these theoretical arguments is Sweden; a relatively small but geographically dispersed nation with a high variation in economic activity. In Sweden, famous cases of clusters or industrial districts consist of biotechnology firms in Copenhagen-Lund and Uppsala-Stockholm (Wennberg & Lindqvist, 2010). The Stockholm area is particularly dynamic. Similarly to other European cities like Copenhagen, Berlin and Munich Stockholm has evolved from a city driven by public institutions, education and research to a metropolitan area increasingly driven by entrepreneurship in a large variety of economic sectors (Acz, Bosma & Sternberg, 2008). In 1994, the year in which our investigation initiates, the greater Stockholm area comprised 30% of Sweden's GNP and the annual start up rate of knowledge-intensive firms per inhabitants ranged between 0.3% and 0.6% in the largest Stockholm municipalities, more than three times the national average. Also in real counts of knowledge-intensive start-ups, the sheer size of Stockholm's economy and population makes it stand out as a entrepreneurial hotspot (see Appendix A).

Insert Figure 1 here

Insert Table 1 here

In Table 1 it is interesting to note that a number of much smaller regions also have a relatively high start-up rate. Among these regions are both affluent areas with a large share of Stockholm expatriates and seasonal workers (Åre and Båstad) but also much smaller rural areas that are neither economically affluent nor dominated by industrial production. In particular, several municipalities in the rural area of Dalarna (Malung and also Ljusdal and Leksand in 1992-1993) are also found among the top municipalities in knowledge intensive start-ups. Dalarna has been depicted as a region with a weak industrial base and also lacking a knowledge inducing sector of colleges and universities. Our data shows that the average level of education in these municipalities is quite low and the number of engineers and scientists in the lower 3rd percentile of the whole country. What, then, can explain the high rate of start-up activities in these regions? One potential explanation is local culture and another is political regulations (Gianetti & Simonov, 2007). The public government in these municipalities switched on average two times during the 1990s, indicating that significant changes in socio-political governance structure might have occurred. It should be pointed out that this association between political governance and entry rates is correlated but not necessarily causal. That is, it might not be the shift in political governance to a right-wing majority but rather a trend towards deregulation or other pro-market forces that are indirectly associated with political governance, that are the true determinant for the higher entry rates in municipalities such as Malå, Malung, Ljusdal and Leksand in the mid-1990s. Another potential explanation pertains to the local culture. According to Johnson's (2008) study of entrepreneurial regions, the socioeconomic heritage in Dalarna of low incomes and a "do it yourself" culture of mixed farming, seasonal work and home-based small manufacturing has led to a strong tradition of small business activities in Dalarna compared to other similar regions. In such areas, the tradition of combining employment and self-employment as a mean to make enough earnings has again become more important as the industrial economy is gradually replaced by a knowledge intensive economy (Folta, Delmar & Wennberg, 2010). But there are even more striking examples of entrepreneurial municipalities in Table 1. A foremost example is the country of Arjeplog, one of the most northern municipalities in Sweden. Here, the cost of transportation to other areas is huge, the average education is low, and there are few nearby colleges or industrial hubs suggesting little possibility of knowledge spillovers. Yet, in 2001 Arjeplog had the 7th highest number of start-ups per inhabitants and in 1994 it topped the list for overall Sweden.[2] This small hub of entrepreneurial activity can be attributed to the development in the 1980s of a car testing facilities for extreme temperatures. Within a few years, subsidiaries of multinational car corporations as well as independent start-ups gathered in Arjeplog to take advantage of the cheap land and basic labor costs, but with close accessibility to world-class research and testing facilities. Today more than 1,000 people from the car testing industry work at Arjeplog, and the industry's investment exceeds 55mil. €,

[2] The figures also for other years are high, in 1993 Arjeplog had the 3rd largest number of start ups and other years it was among the higher percentiles within the country

a prima mode example of how entrepreneurial hotspots can emerge in any region, even the extremely remote ones, through knowledge spillovers.

However, with the exception of Dalarna and Arjeplog, the main urban areas of Malmö, Göteborg, and in particular Stockholm dominate the picture for knowledge-intensive start-ups. The predominant role of Stockholm as an engine of entrepreneurial growth in Sweden can be generalized to other contexts with the help of theoretical models of economic geography and population ecology depicted above. Because agglomerations are often much higher in urban areas, the increasingly 'spatial' nature of entrepreneurship and especially growth-oriented entrepreneurship mean that the level of *ambition* in entrepreneurship rises where competition and local growth-prone institutions are existent (Autio & Acs, 2007). This can be seen around the world through the increasing rates of entrepreneurship in urbanized region. This pattern is strongly accentuated in Sweden where a few metropolitan areas, in particular Stockholm, comprise a large and increasing share of entrepreneurship and economic growth. The benefits of urban size for new firms are many: Large urban economies bring with them greater industrial and occupational diversity that facilitate the transfer of new innovations across industries (Jacobs, 1969; Rosenthal & Strange, 2005).

Data

Our empirical analysis focuses on how characteristics of the economic milieu of regions influence firm births. For this purpose we employ the unique database maintained by Statistics Sweden : RAMS, which provides yearly data on all firms registered in Sweden; privately and publicly held firms, incorporations as well as partnerships and proprietorships. We used RAMS to sample all privately owned firms started between 1994 and 2002 in the knowledge-intensive sectors. Three considerations motivated the time period we chose: 1) The time period 1990-1993 was an extreme period with the lowest economic activity in Sweden since the Great depression. Since we are interested in how variation in contextual factors across regions affects firm births, basing our analysis on such a period could taint our results; 2) Several years of start-up history are needed to avoid cohort effects. For analyzing the contextual influences on firm births it is necessary to create a measure of births at the regional level. We did this by aggregating all yearly start-ups to the municipality level for each of the years 1994 to 2002 by summing all firm entries into a total value for the municipality. A value of 23 thus implies that 23 births occurred in municipality i at time j. We use a slightly narrower time frame than in preceding research since some of the important predictor variable where only available from 1994 onwards. 3) Several of our predictor variables are were not available until 1994. The knowledge-intensive sectors in our sample constitute the complete set of high-technology manufacturing or knowledge-intensive service sectors, according to Eurostat and OECD classifications of such sectors (Götzfried 2004). In total, 22 5-digit industry codes equivalent to the U.S. Standard Industrial Classification (SIC) system are included in the sample, comprising roughly 33% of the Swedish economy but over 40% of employment. See Appendix B for a complete list of sectors included.

Dependent variable

The level of analysis in our investigation is the individual municipality and the focal variable of interest is firm births (There are 286 municipalities in Sweden,. To analyze how the regional characteristics described above affect firm births we use of the Negative Binomial (NEGBIN) regression model. This model is commonly used for analyses of count data (see e.g. Cameron & Trivedi 1998) and is appropriate if the mean exceeds the variance in birth. The number of start-ups are count data and take on discrete vales 0, 1, 2… ,etc. up to a maximum of 3,174, which is the highest number of births in a municipality (Stockholm in

1999) during the time period of investigation. The average number of births is 32 but the median number is only 13, hence indicating highly skewed values as shown in the kernel density figure below. This substantiates the usage of count data analysis.

Insert Figure 2 here

Independent variables

Our analytical model is constructed in such a way so that it captures both supply- and demand-side factors, however with a specific emphasis on the demand side. Much of the existing literature on the link between entrepreneurship and characteristics of regions focuses on supply-side factors. We therefore control for supply-side effects that pertain to knowledge. The bulk of papers on differences in entrepreneurship across regions pay particular attention to the impact of concentrations of human capital and knowledge based investments in space.[3] These often builds on the ‘knowledge spillover theory of entrepreneurship’ (Acs et al., 2009), focusing on the sources of knowledge that lead to the creation and development of new firms. The essence of the theory is that spillovers of knowledge and information are more frequent in regions with high densities of human capital and knowledge based investments. Because of this, potential and existing entrepreneurs have higher probability of accessing knowledge that can constitute the basis for a new firm, such that accessibility to knowledge sources trigger start-ups. On the supply-side we include the overall knowledge-intensity of the workforce in the municipality. This variable –‘ *% College educated*’ – is defined as the share of workers with a university education of at least three years. We also include a dummy for the presence

[3] Audretsch and Lehman (2006) suggest some theoretical reasons why proximity to knowledge sources might enhance entrepreneurial performance emanate in their “resource theory” of entrepreneurship.

of '*University R&D in region'* and another dummy for the presence of '*Business R&D in a region'*. The variables are in dummy format because threshold they were drawn from an annual survey of R&D among universities and companies exceeding that of the country's average. These three variables are included in view of the knowledge spillover theory of entrepreneurship (Acs et al., 2009) and controls for whether proximity to knowledge sources spurs knowledge-intensive entrepreneurship.

We also investigate sociological variables pertaining to demand-side factors known to affect entrepreneurship (Thornton, 1999). Specifically, we use the two variables suggested as imperative in the density dependency model of population ecology:

Firm Density number of similar firms in existence during the time of founding in a focal municipality (and the squared term Firm Density^2 to investigate non-linearities)[4]. With an increasing number of firms in a new industry – such as IT consulting or Web design – knowledge and publication acceptation of this type of business spreads through media, business activities, and other types of knowledge flows. With increased knowledge this type of business becomes cognitively more accepted, hence alleviating investors and customers' skepticism of the business and thus easing the ability of entrepreneurs to realize their idea in the socio-economic sphere of daily life. The regional count of firms also captures legitimacy – it is easier to find role models on the other side of the street than in a far-away city – however the regional count variable also is a strong indicator of competition, your neighboring firm might turn out to be your strongest competitor as well as a role model. The squared term is included to investigate non-linearities, i.e. when the negative hypothesized effect of

[4] In our chapter investigating firm exits we return to this model and supplement it as to also include explanatory variables from the density delay model in order to investigate the path-dependency of entry conditions in explaining firm survival.

competition on firm births overtakes the positive effect of legitimacy. These variables were taken from the RAMS database.

We include the variable '*Political Majority in region'* as an indication of Institutional conditions in the form of dominant political positions in each municipality. Our interest in this variable arrives from the socio-economic models of firm emergence developed in organization theory (c.f. Lounsbury, 2007). In such models, the birth and demise of organizations is not determined solely by economic forces but is portrayed as a social process shaped by a number of institutional actors such as governments, industrial associations and trade unions that strive to advance their respective interests via persuasion and coercion (DiMaggio & Powell, 1983). The validity of the variable denoting political control of a municipality hinges on the notion that local authorities wields coercive pressure that can hamper or facilitate the start-up activities of local firms, for example, by indirectly or influencing public administrators to avoid or delay application procedures and approval of operation in cases such applications are necessary. Obviously, this does not imply corruption but merely that socio-cultural practice depends on the people set to administer such practices, and who dictates local parliamentary matters for administration and legislation. The interpretation of this variable demands caution since we cannot ascertain the exact theoretical mechanism by which the variable operates. Change in local governance might provide a source of socio-political legitimacy and/or simultaneously lead to some factual institutional reforms, and we cannot distinguish between the two. Similar to Gianetti and Simonov (2007) this variable takes the value -1 for socialistic majority, 1 for right-wing majority, and 0 for a mixed (coalition) majority, taken from Statistics Sweden's public databases.

We investigate economic conditions that differ across municipalities and over time by four different variables. First, 'GRP in region' controls for the general economic size of each municipality with a measure of Gross Regional Product (GRP). We also control for the *'Median income in region*' with a measure of income per capita in a focal municipality (approximates both supply of potential entrepreneurs and demand for their services). Finally, we introduce three dummy variables denoting regional characteristics of the local economy: *'Metropolitan area'* is a dummy variable taken the value 1 for large urban areas and 0 otherwise. '*Large Public Sector'* takes the value 1 for municipalities that are dominated by public sector employment and 0 otherwise. '*Large Agricultural Sector'* takes the value 1 for municipalities that that have a large agricultural sector (10% or more of GRP) or 0 otherwise. All these variables were taken from Statistics Sweden's public databases.

Since the data constitutes a repeated cross-sectional time series panel, we include dummy variables for each year of analysis to control for unobservable effects pertaining to the economic cycle. All variables are time varying between 1994 and 2002, updated yearly for each municipality. The variables are summarized in table 2. The maximum and minimum values, mean values, and their correlations are displays in appendix B. We estimate separate models for the births of High-Tech Manufacturing Firms and the Births of Knowledge Intensive Services (KIBS) Firms. In both model, our variables for local economic conditions, ecological conditions, Knowledge spillovers and institutional conditions are entered hierarchically, with separate test of log-likelihood ratio to investigate the improvement in model fit when each block of variables are introduced.

Insert Table 2 here

RESULTS

Table 3 shows negative binomial regression models of firm births across all Swedish municipalities during the time period of analysis. We show separate models for high-tech start-ups and knowledge-intensive business services (KIBS), the latter representing the majority of firm births by far. Our results show that both supply- and demand-side factors matter for KIBS start-ups by the category of individuals studied, but that demand-side factors dominate. In terms of local conditions, the coefficients for both municipality GRP and median income among residents show positive effects on firm birth for both high-tech and business services start-ups. The positive effects are most pronounced in the coefficient for median income. Although this is a control variable, the effect is supportive of the notion that demand side factors are important determinants of firm births. The dummy variable denoting the presence of a large agricultural sector in a municipality reveal negative effects on all types of firm birth, however the presence of a large public sector in a municipality has a positive effect, contrary to expectation. This indicates that a high level of public spending does not necessarily crowd out entrepreneurship in the municipality.

Insert Table 3 here

We now turn to investigate the theoretical variables of interest: ecological conditions, knowledge spillovers, and the effect of the local regulatory regime. Ecological conditions enter our analysis according to the density-dependency model with linear and squared coefficients for the number of firms in the same industry present in the overall country[5]. The density model predicts that linear effect should be positive for the emergence of new organizations due to the enhancing effect of legitimacy through a 'safety in numbers' logic, but that the quadratic effect should be negative due to the competition that follows with large numbers of similar firms vying to occupy a part of the market space. Tables 3 and 4 demonstrate support of both effects for the birth of knowledge intensive service firms, and high-tech manufacturing firms respectively. The effects are especially pronounced for high-tech manufacturing firms despite the fact that the number of service firms is vastly higher.

Insert Table 4 here

The multivariate analysis of firm births in the knowledge intensive sector revealed strong support for our demand-based model of firm births. Ecological conditions as well as knowledge spillovers, and the local regulatory regime exhibited strong influence on the number of new firms across Swedish municipalities. Can we argue further about the relative size of these effects? Calculating marginal effects enables this (the relative change in the outcome variable given a one unit increase in the predictor variable, also called Instant Incident Ratios, IIR). Calculation of marginal effects for our key predictor variables show that holding all other variables constant at their means, the shift in political dominance in a municipality from left wing to right wing increase the number of KIBS start-ups by 6%, but

[5] We experimented also with density variables on both the national and regional level but this made the models difficult to converge. Quite possible, the number of firms in a small country such as Sweden is too limited to be measured locally. This is not a theoretical problem, since the arguments behind competition and legitimacy in the density dependency model suggest that competition can be both local and national while the effect of legitimacy operates much more nationally – or even internationally (Hannan et., 1995).

has no effect on high-tech manufacturing start-ups. A likely explanation is that entry and exit barriers are higher for manufacturing firms, hence their set-up costs are higher and the short-term influence of a change in regulatory regime (regardless of whether this provide a source of socio-political legitimacy or simultaneously lead to some factual institutional reforms) is little. This represents 29 new firms for the average municipality. Similarly, the presence of business R&D in the municipality (measured by a dummy variable) increase the number of KIBS start-ups by 42%, while the presence of strong University R&D in the municipality increase the number of KIBS start-ups by a whopping 52%. The effects for high-tech start-ups is similar but more closely linked to University R&D (57% marginal effect) compared to business R&D (28%). The marginal effects size thus reveal substantial influence of both economic and sociological demand-side variables on firm birth, substantiating the relevance of research exploring the geographic source of demand-side factors affecting entrepreneurial processes. Since our unit of analysis in this paper is the local municipality, our model conceals a substantial heterogeneity in what type of firms that is founded. It is possible that the demand-side variables of economic and sociological type identified are contingent depending on the size, composition, and scope of activities of the new firm. More advanced analysis would be necessary to investigate such contingencies.

DISCUSSION

In this paper we investigated the role of geographic factors, such as university knowledge spillovers, for the birth of new knowledge intensive firms. To challenge prevailing frameworks focusing mainly on supply-side economic factors, we integrated insights from economic geography and population ecological research on firm births in our analytical framework. The empirical analysis of birth rates of knowledge intensive firms across all

Swedish 286 municipalities during the period 1994-2002 revealed a number of interesting patterns. We found that the level of firm births varied strongly across municipalities. Large and economically dominant regions such as greater Stockholm, and Malmö-Lund dominated entrepreneurial activity in terms of firm births, yet a number of much smaller rural municipalities revealed high levels of start-ups. We demonstrate that both economic and sociological variables of demand-side type exhibited strong influences on firm births across Swedish municipalities. Knowledge spillovers from universities and firm R&D apparently play a strong role by positively influencing the number of births, as do the regulatory regime within the municipality. It is possible however that our findings in relationship with the local regulatory regime being influenced by a left or right leaning government, can be attributed to other, hitherto unmeasured, factors. While these types of analyses are still rare in the literature, a somewhat similar study by Wagner and Sternberg (2004) investigated start-up behavior on ten German planning regions and found that start-up behavior was more frequent in densely populated and faster growing regions, while it did not matter whether the region has a left or right leaning government. These are interesting findings that should be worthy of further investigation. In unreported models estimated separately for each year of analysis we found the effect of regulatory regime to be strongest in 1994, 1995 and 1996 and then diminished during the latter half of the observation period. That indicates that during the 1990s, the regulatory regime became less important for start-up efforts among knowledge intensive firms in the nation we study. This may indicate that the public legitimacy of entrepreneurship increased as a whole.

All of our results point to support for the notion of 'the geographic connection' as an important factor for analyzing entrepreneurial processes. Our analysis posits a number of research questions for further investigation. The large variety in firm birth rates between municipalities implies that more intricate analyses of outliers – both low entrepreneurial regions and high entrepreneurial regions could provide interesting evidence. But we would like to add that it is specifically regions that ‘goes against the tide’, that is, low-entrepreneurship regions where firm births suddenly increases, that merits specific investigation. The prevalence of a high start-up rate in a number of small and rural municipalities suggests that more fine-grained social-cultural or historical analyses of such regions might be fruitful. These interesting outliers notwithstanding, our overall analyses posits strong path-dependency in firm births which works in tandem with recent economic studies focusing on the ‘persistence in start-up rates’ across regions (Andersson & Koster, 2011). Also, research in organization theory maintains that the spatial dimensions for the emergence and spread of new firms remain an under-researched topic (Cattani, Pennings & Wezel, 2003). Such theories have suggested that social networks of individuals and firms may play a role in ‘spreading’ entrepreneurial efforts. From a historical perspective, how patterns of firm births evolve across regions and how this persists over longer periods of time – even decades – remains an interesting question for future research.

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Figure 1: Municipalities with highest relative entry rate (shaded) 1994-2002

Figure 2: Kernel density estimate of knowledge-intensive start-ups in Swedish municipalities 1994-2002.

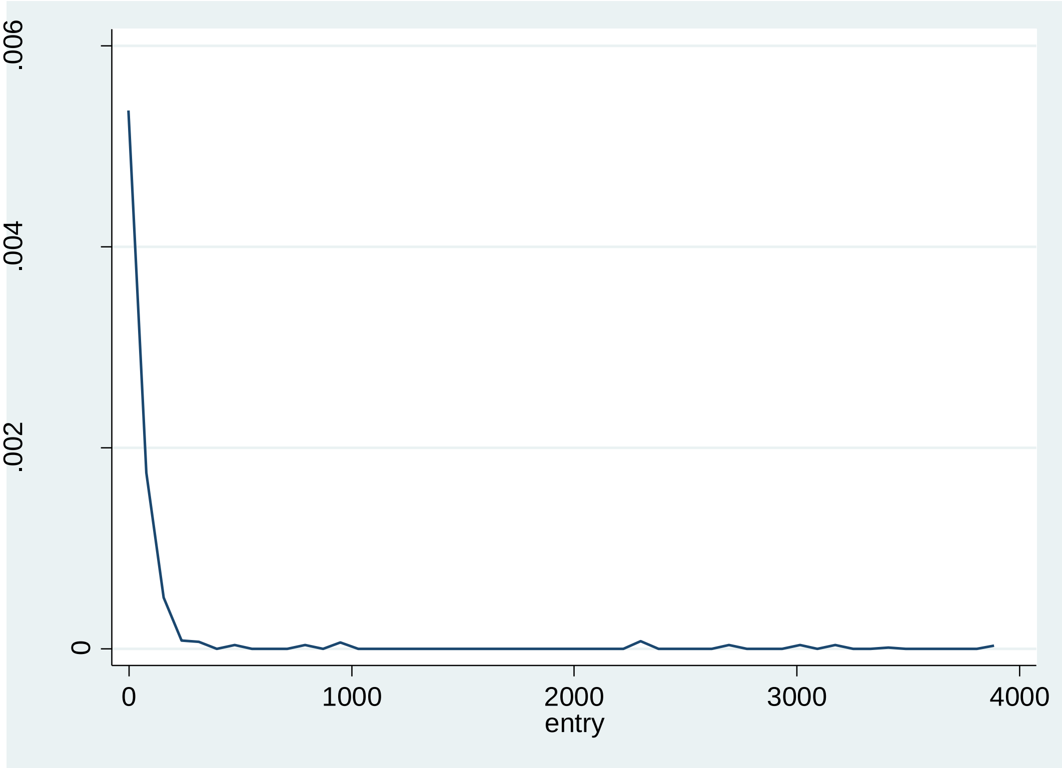

Table 1: The 10 municipalities with highest relative entry rate 1994-2002

1994		**1995**		**1996**		**1997**		**1998**		**1999**		**2000**		**2001**		**2002**	
Sollentuna	0.32%	Nyköping	0.32%	Nacka	0.31%	Vallentuna	0.40%	Solna	0.35%	Strömstad	0.31%	Göteborg	0.35%	Höganäs	0.37%	Vellinge	0.36%
Vallentuna	0.33%	Sollentuna	0.32%	Sollentuna	0.31%	Österåker	0.40%	Sollentuna	0.38%	Sollentuna	0.32%	Sollentuna	0.36%	Vellinge	0.37%	Lomma	0.36%
Solna	0.37%	Håbo	0.32%	Båstad	0.32%	Nyköping	0.41%	Malå	0.38%	Nacka	0.36%	Värmdö	0.40%	Malung	0.40%	Värmdö	0.39%
Nacka	0.37%	Nacka	0.32%	Ekerö	0.33%	Nacka	0.41%	Vallentuna	0.39%	Ekerö	0.37%	Solna	0.42%	Arjeplog	0.45%	Sollentuna	0.41%
Täby	0.44%	Vallentuna	0.33%	Lomma	0.33%	Ekerö	0.46%	Täby	0.46%	Åre	0.38%	Nacka	0.44%	Täby	0.51%	Vaxholm	0.42%
Vaxholm	0.48%	Vaxholm	0.39%	Täby	0.41%	Vaxholm	0.47%	Vaxholm	0.50%	Vaxholm	0.42%	Vaxholm	0.49%	Nacka	0.52%	Nacka	0.44%
Lidingö	0.51%	Täby	0.49%	Vaxholm	0.42%	Täby	0.55%	Nacka	0.53%	Täby	0.43%	Täby	0.54%	Vaxholm	0.57%	Täby	0.49%
Stockholm	0.54%	Lidingö	0.50%	Lidingö	0.45%	Lidingö	0.67%	Stockholm	0.65%	Lidingö	0.47%	Lidingö	0.55%	Danderyd	0.59%	Lidingö	0.58%
Danderyd	0.55%	Stockholm	0.53%	Danderyd	0.49%	Stockholm	0.70%	Lidingö	0.65%	Stockholm	0.57%	Danderyd	0.65%	Lidingö	0.61%	Danderyd	0.62%
Arjeplog	0.55%	Danderyd	0.63%	Stockholm	0.50%	Danderyd	0.76%	Danderyd	0.68%	Danderyd	0.58%	Stockholm	0.81%	Stockholm	0.73%	Stockholm	0.70%

Note: Entry rate computed as start up rate of knowledge-intensive firms per number of inhabitants

Table 2: Explanatory variables in the empirical analysis (conditions across municipalities).

Type of variable	**Variable**	***Explanation***
Economic conditions	GRP	Gross Regional Product
Economic conditions	Median Income	Median income per capita in municipality
Economic conditions	Agriculture	Dummy for a large agriculture sector (35% employment) in municipality
Economic conditions	Public sector	Dummy for a large public sector (>35% employment) in municipality
Ecological conditions	Density	Number of firms (KIBS or high tech manufacturing firms, respectively) in municipality
Ecological conditions	$Density^2$	Squared number of firms (KIBS or high tech manufacturing firms, respectively) in municipality
Knowledge spillovers	College Educated	Proportion of College Educated in the municipality
Knowledge spillovers	University R&D	Dummy for the presence of university R&D in the municipality (1 of positive R&D investments, 0 otherwise)
Knowledge spillovers	Business R&D	Dummy for the presence of business R&D in the municipality (1 of positive R&D investments, 0 otherwise)
Institutional conditions	Politics	Political majority in municipality (-1= socialistic majority, 0= mixed majority, 1=right wing majority)

Table 3: NEGBIN Models of Births of High-Tech Manufacturing Firms

	Model 1	**Model 2**	**Model 3**	**Model 4**
GRP in region	0.00***	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Median Income in region	0.01***	0.01*	0.01**	0.01**
	(0.00)	(0.00)	(0.00)	(0.00)
Metropolitan area	0.19	-3.72***	-3.57***	-3.63***
	(0.34)	(0.31)	(0.34)	(0.34)
Large Public Sector	0.37***	0.27***	0.29***	0.30***
	(0.06)	(0.06)	(0.06)	(0.06)
Large Agricultural Sector	-0.81***	-0.42***	-0.39***	-0.36***
	(0.09)	(0.09)	(0.09)	(0.09)
Firm Density		0.06***	0.05***	0.05***
		(0.00)	(0.00)	(0.00)
Firm Density^2		-0.00***	-0.00***	-0.00***
		(0.00)	(0.00)	(0.00)
% College educated		0.00	-0.01	-0.01
		(0.01)	(0.01)	(0.01)
Business R&D in region			0.18*	0.17*
			(0.07)	(0.07)
University R&D in region			-0.01	-0.02
			(0.08)	(0.08)
Political Majority in region				-0.05
				(0.04)
Constant	-2.00***	-1.93***	-2.12***	-2.25***
	0.48	0.42	(0.44)	(0.45)
(ln)alpha	-0.27**	-2.08***	-2.16***	-2.15***
	(0.09)	(0.24)	(0.26)	(0.26)
Log. Likelihood	-2639.62	-2353.52	-2350,20	-2349,19
Δ Log-likelihood:		572.20**	6.64*	2.02
Pseudo R-2 (McFadden's)	0.14	0.24	0.24	0.24
Chi-2 statistic :	879.32	1451.52	1458.16	1460.18
Chi-2 p-value:	0.001	0.001	0.001	0.001

Notes: Year dummies included but not reported. ΔLR is for improvement in model fit versus base model. + p <.10, * p <.05, ** p <.01, *** p <.001. (two-tailed). Huber White Standard Errors in Parenthesis.

Table 4: NEGBIN Models of Births of KIBS Firms

	Model 1	Model 2	Model 3	Model 4
GRP in region	0.00***	0.00***	(0.00)	0.00*
	(0.00)	(0.00)	(0.00)	(0.00)
Median Income in region	0.03***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
Metropolitan area	-2.46***	-4.23***	-3.54***	-3,42***
	(0.21)	(0.21)	-0.21	(0.21)
Large Public Sector	0.34***	0.18***	0.18***	0.19***
	(0.03)	(0.03)	(0.03)	(0.03)
Large Agricultural Sector	-0.20***	-0.17***	-0.13***	-0.17***
	(0.04)	(0.03)	(0.03)	(0.03)
Firm Density		0.00***	0.00***	0.00***
		(0.00)	(0.00)	(0.00)
Firm Density²		-0.00***	-0.00***	-0.00***
		(0.00)	(0.00)	(0.00)
% College educated		0.02***	0.02***	0.02***
		(0.00)	(0.00)	(0.00)
Business R&D in region			0.30***	0.30***
			(0.03)	(0.03)
University R&D in region			0.25***	0.27***
			(0.04)	(0.04)
Political Majority in region				0.08***
				(0.02)
Constant	-1.96***	0.17	-0.25	-0.17
	(0.25)	(0.25)	(0.25)	(0.25)
(ln)alpha	-0.60***	-1.07***	-1.13***	-1.14***
	(0.03)	(0.03)	(0.03)	(0.03)
Log. Likelihood	-9776.18	-9245,62	-9179,96	-9169,03-
Δ Log-likelihood:		1061.12**	131.31**	21.87**
Pseudo R-2 (McFadden's)	0.15	0.20	0.21	0.21
Chi-2 statistic	3555.7	4616.82	4748.13	4770
Chi-2 p-value:	0.001	0.001	0.001	0.001

Notes: Year dummies included but not reported. ΔLR is for improvement in model fit versus base model. + *p* <.10, * *p* <.05, ** *p* <.01, *** *p* <.001. (two-tailed). Huber White Standard Errors in Parenthesis.

Appendix A: 10 municipalities with highest absolute entry rate 1994-2002

1994		**1995**		**1996**		**1997**		**1998**		**1999**		**2000**		**2001**		**2002**	
Örebro	147	Helsingborg	153	Örebro	119	Örebro	176	Helsingborg	161	Linköping	131	Linköping	164	Lidingö	142	Örebro	153
Lund	155	Örebro	154	Linköping	122	Nacka	178	Västerås	162	Lund	136	Helsingborg	181	Linköping	145	Västerås	165
Helsingborg	156	Lund	160	Nacka	133	Västerås	183	Linköping	166	Västerås	139	Västerås	182	Helsingborg	177	Täby	177
Nacka	156	Västerås	169	Västerås	137	Lund	183	Täby	169	Helsingborg	152	Täby	194	Täby	185	Helsingborg	197
Täby	158	Linköping	174	Täby	150	Täby	199	Lund	178	Täby	157	Nacka	201	Lund	229	Lund	200
Västerås	204	Täby	177	Lund	172	Linköping	201	Nacka	234	Nacka	159	Lund	203	Nacka	239	Nacka	203
Uppsala	250	Uppsala	262	Uppsala	257	Uppsala	342	Uppsala	322	Uppsala	290	Uppsala	358	Uppsala	321	Uppsala	318
Malmö	358	Malmö	371	Malmö	311	Malmö	463	Malmö	428	Malmö	370	Malmö	500	Malmö	473	Malmö	500
Göteborg	775	Göteborg	790	Göteborg	753	Göteborg	949	Göteborg	954	Göteborg	736	Göteborg	1015	Göteborg	898	Göteborg	856
Stockholm	2302	Stockholm	2299	Stockholm	2204	Stockholm	3174	Stockholm	3013	Stockholm	2694	Stockholm	3884	Stockholm	3541	Stockholm	3405

Appendix B: Modal values and correlation matrix for variables in analyses of firm births

	Mean	S.D.	Min	Max	Births	GRP	Median Income	Metropolitan area	Large public Sector	Large agricultural Sector	Firm Density	Firm Density^2	% College educated	Business R&D	University R&D
Births	39.06	178.9	1	3782											
GRP	7139	21838	1	4E+05	0.969										
Median Income	175.1	21.04	126.7	273.8	0.076	0.076									
Metropolitan area	0.01	0.1	0	1	0.743	0.799	-0.02								
Large Public Sector	0.44	0.5	0	1	-0.03	-0.038	-0.02	-0.091							
Large Agricultural Sector	0.31	0.46	0	1	-0.112	-0.151	-0.24	-0.070	0.023						
Firm Density	278.1	1153	2	22972	0.994	0.981	0.085	0.761	-0.03	-0.119					
Firm Density^2	1E+06	2E+07	4	+05	0.945	0.879	0.054	0.600	-0.053	-0.045	0.938				
% College educated	3.6	3.99	0	29.07	0.344	0.368	0.249	0.206	0.018	-0.301	0.349	0.211			
Business R&D	0.62	0.49	0	1	0.118	0.185	0.071	0.082	-0.127	-0.235	0.129	0.052	0.274		
University R&D	0.16	0.37	0	1	0.277	0.367	0.021	0.238	0.179	-0.190	0.294	0.149	0.259	0.205	
Political Majority	-0.12	0.85	-1	1	0.018	-0.03	0.012	-0.03	-0.083	0.223	0.015	0.011	0.075	-0.066	-0.099

Appendix C: Sector code descriptions for the sample of knowledge intensive industries (SIC equivalent

Sector	Description	SIC codes
	Manufacturing	**15 to 37**
(1)	High-tech manufacturing	30, 32 and 33
(2)	Medium high-tech manufacturing	24, 29, 31, 34 and 35
	Services	**50 to 99**
(3)	High-tech services	64, 72, 73
(4)	Business services	61, 62, 70, 71, 74
(5)	Financial services	65, 66, 67
(6)	Other knowledge-intensive services	80, 85, 92