CHAPTER 2

THE MOBILITY OF ECONOMIC AGENTS AS CONDUITS OF KNOWLEDGE SPILLOVERS

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1. INTRODUCTION

This volume brings two relatively new concepts together – the mobility of economic agents and knowledge spillovers. Not only is research on each of these phenomenon limited, but understanding about the intersection of these two concepts is virtually non-existent. While most of this Volume focuses on filling this void and making an explicit link between agent mobility and knowledge spillovers, it is also important to understand why such a link is important in the first place. This chapter provides a context explaining not only why the mobility of economic agents serves as a conduit of knowledge spillovers, but even more importantly, why this function matters for economics. In particular, it matters for economic growth. Economic growth has been a dominant concern in economics, dating back at least to the classical economists. In the post-war models of economic growth, neither knowledge nor knowledge spillovers had any relevance for economic growth.

When Robert Solow (1956) proposed a model of economic growth, the production function emerged as the basis for explaining the determinants of economic growth. According to the neoclassical model of the production function, two key factors of production – capital and labor – provided the inputs for output and growth.

The role of science and knowledge is not particularly obvious in the neoclassical model of the production function. The implications from this model were that (1) the impact of science and ideas was essentially embodied in capital, and (2) the mobility of scientists, engineers and other knowledge workers should have no significance other than labor mobility in general. That is, labor mobility was generally viewed as important because it is a mechanism for equilibrating wages in the labor market.

Romer's (1986) critique of the Solow approach was not with the basic model of the neoclassical production function, but rather what he perceived to be omitted from that model – knowledge. Not only did Romer (1986), along with Lucas (1988) and others argue that knowledge was an important factor of production, along with the traditional factors of labor and capital, but because it was endogenously determined as a result of externalities and spillovers, it was particularly important.

The purpose of this paper is to suggest that the recognition and inclusion of knowledge as an important factor has additional implications involving the mechanisms by which that knowledge spills over. While both the traditional and new growtheories have in common a macroeconomic unit of observation, in this paper the focus is on the microeconomic unit of analysis – the individual knowledge workers. Shifting the lens of analysis to the individual knowledge worker turns out to be significant. In a model where knowledge has economic value, individuals make decisions about investing in knowledge as well as appropriating the returns to those knowledge investments. As this paper suggests, an important implication is that the mobility of knowledge workers in general, and the startup of new firms in particular, becomes an important mechanism by which knowledge spills over.

2. THE KNOWLEDGE PRODUCTION FUNCTION

Contrary to the approach where the unit of analysis on innovation and technological change for most theories of innovation is the firm (Cohen and Levin, 1989; Griliches, 1979, in this paper we will instead focus on the individual. In the traditional theories, the firms are exogenous and their performance in generating technological change is endogenous (Cohen and Levin, 1989).

For example, in the most prevalent model found in the literature of technological change, the model of the knowledge production function, formalized by Zvi Griliches (1979), firms exist exogenously and then engage in the pursuit of new economic knowledge as an input into the process of generating innovative activity.

The most important input in the model of the knowledge production function is new economic knowledge. As Cohen and Klepper point out, the greatest source generating new economic knowledge is generally considered to be R&D (Cohen and Klepper, 1991 and 1992). Other inputs in the knowledge production function have included measures of human capital, skilled labor, and educational levels (Griliches, 1979 and 1992). Thus, the model of the knowledge production function from the literature on innovation and technological change can be represented as

$$I_i = \alpha RD_i^{\beta} HK_i^{\gamma} \varepsilon_i \tag{1}$$

where *I* stands for the degree of innovative activity, *RD* represents R&D inputs, and *HK* represents human capital inputs. The unit of observation for estimating the model of the knowledge production function, reflected by the subscript *i,* has been at the level of countries, industries and enterprises (Griliches, 1984)

Empirical estimation of the model of the knowledge production function, represented by Equation (1), was found to hold most strongly at broader levels of aggregation (Griliches, 1979, 1992). Empirical evidence (Griliches, 1992) clearly supported the existence of the knowledge production function at the unit of observation of countries. This is intuitively understandable, because the most innovative countries are those with the greatest investments to R&D. little innovative output is associated with less developed countries, which are characterized by a paucity of production of new economic knowledge.

Similarly, the model of the knowledge production function was found to exist at the level of the industry (Griliches, 1979). The most innovative industries also tend to be characterized by considerable investments in R&D and new economic knowledge. Not only are industries such as computers, pharmaceuticals and instruments high in R&D inputs that generate new economic knowledge, but also in terms of innovative outputs. By contrast, industries with little R&D, such as wood products, textiles and paper, also tend to produce only a negligible amount of innovative output. Thus, the knowledge production model linking knowledge generating inputs to outputs certainly holds at the more aggregated levels of economic activity.

Where the relationship became problematic was at the disaggregated microeconomic level of the enterprise, establishment, or even line of business. While Audretsch (1995) found that the simple correlation between R&D inputs and innovative output was 0.84 for four-digit standard industrial classification (SIC) manufacturing industries in the United States, it was only about half, 0.40 among the largest U.S. corporations.

The model of the knowledge production function becomes even less compelling in view of the recent wave of studies revealing that small enterprises serve as the engine of innovative activity in certain industries. For example, Audretsch (1995) found that while large enterprises (defined as having at least 500 employees) generated a greater number of new product innovations than did small firms (defined as having fewer than 500 employees), once the measures were standardized by levels of employment, the innovative intensity of small enterprises was found to exceed that of large firms. The innovation rates, or the number of innovations per thousand employees, have the advantage in that they measure large- and small-firm innovative activity relative to the presence of large and small firms in any given industry. That is, in making a direct comparison between large- and small-firm innovative activities, the absolute number of innovations contributed by large firms and small enterprises is somewhat misleading, since these measures are not standardized by the relative presence of large and small firms in each industry. When a direct comparison is made between the innovative activity of large and small firms, the innovation rates are presumably a more reliable measure of innovative intensity because they are weighted by the relative presence of small and large enterprises in any given industry. Thus, while large firms in manufacturing introduced 2,445 innovations, and small firms contributed slightly fewer, 1,954, small-firm employment was only half as great as large-firm employment, yielding an average small-firm innovation rate in manufacturing of 0.309, compared to a large-firm innovation rate of 0.202 (Audretsch, 1995).

These results are startling, because the bulk of industrial R&D is undertaken in the largest corporations; and small enterprises account only for a minor share of R&D inputs, raising the question of where such firms obtained access to R&D inputs. Either the model of the knowledge production did not hold, at least at the level of the enterprise (for a broad spectrum across the firm-size distribution), or else the appropriate unit of observation had to be reconsidered. In searching for a solution, scholars chose the second interpretation, leading them to move towards spatial units of observation as an important unit of analysis for the model of the knowledge production function.

3. KNOWLEDGE SPILLOVERS

As it became apparent that the unit of analysis of the enterprise was not completely adequate for estimating the model of the knowledge production function, scholars began to look for externalities. In refocusing the model of the knowledge production to a spatial unit of observation, scholars confronted two challenges. The first one was theoretical. What was the theoretical basis for knowledge to spill over yet, at the same time, be spatially bounded within some geographic unit of observation? The second challenge involved measurement. How could knowledge spillovers be measured and identified? More than a few scholars heeded Krugman's warning (1991, p. 53) that empirical measurement of knowledge spillovers would prove to be impossible because "knowledge flows are invisible, they leave no paper trail by which they may be measured and tracked."

In confronting the first challenge, which involved developing a theoretical basis for geographically bounded knowledge spillovers, scholars turned towards the incipient literature on the new economic geography. In explaining the asymmetric distribution of economic activity across geographic space, Krugman (1991) and Romer (1986) relied on models based on increasing returns to scale in production. By increasing returns, however, Krugman and Romer did not necessarily mean at the level of observation most familiar in the industrial organization literature – the plant, or at least the firm – but rather at the level of a spatially distinguishable unit, say a region or area. In fact, it was assumed that externalities across firms and even industries that yield convexities in production. In particular, Krugman (1991) focused on convexities arising from spillovers from (1) a pooled labour market; (2) pecuniary externalities enabling the provision of nontraded inputs to an industry in a greater variety and at lower cost; and (3) information or technological spillovers.

That knowledge spills over was barely disputed. Arrow (1962) had identified the externalities associated with knowledge, in particular the non-exclusivity and non-rivalrous use. However, the geographic range of such knowledge spillovers has been greatly contested. In disputing the importance of knowledge externalities in explaining the geographic concentration of economic activity, Krugman (1991) and others did not question the existence or importance of such knowledge spillovers. In fact, they argue that such knowledge externalities are so important and forceful that there is no compelling reason for a geographic boundary to limit the spatial extent of the spillover. According to this line of thinking, the concern is not that knowledge does not spill over but that it should stop spilling over just because it hits a geographic border, such as a city limit, state line, or national boundary.

Rather, in applying the model of the knowledge production function to spatial units of observation, not only were theories of knowledge externalities needed but also theories about why those knowledge externalities should be spatially bounded. Thus, it took the development of localization theories explaining not only that knowledge spills over but also why those spillovers decay as they move across geographic space.

Such theories of localization (Jacobs, 1969) suggest that *information,* such as the price of gold on the New York Stock Exchange, or the value of the Yen in London, can be easily codified and has a singular meaning and interpretation. By contrast, *knowledge* or what is sometimes referred to as *tacit knowledge,* is vague, difficult to codify and often only serendipitously recognized. Information is codified and can be formalized, written down, but tacit knowledge is non-codifiable and cannot, by definition, be formalized and written down. Geographic proximity matters in transmitting knowledge, because as Kenneth Arrow (1962) pointed out some three decades ago, such tacit knowledge is inherently non-rival in nature, and knowledge developed for any particular application can easily spill over and have economic value in very different applications. As Glaeser, Kallal, Scheinkman and Shleifer (1992, p. 1126) have observed, “intellectual breakthroughs must cross hallways and streets more easily than oceans and continents.”

Feldman (1994) developed the theory that firms cluster to mitigate the uncertainty of innovation, proximity enhances the ability of firms to exchange ideas, discuss solutions to problems, and be cognizant of other important information, hence reducing uncertainty for firms that work in new fields. In addition, Feldman (1994) further suggests that firms producing innovations tend to locate in areas where there are necessary resources and that resources accumulate due to a region's past success with innovations.

An implication of the distinction between information and tacit knowledge is the marginal cost of transmitting information across geographic space has been rendered invariant by the telecommunications revolution, while the marginal cost of transmitting knowledge, and especially tacit knowledge, rises with distance.

Studies identifying the extent of knowledge spillovers are based on the model of the knowledge production function applied at spatial units of observation. In what is generally to be considered to be the first important study refocusing the knowledge production function, Jaffe (1989) modified the traditional approach to estimate a model specified for both spatial and product dimensions:

$$I_{si} = \alpha IRD^{\beta_1} UR_{si}^{\beta_2} (UR_{si} GC_{si}^{\beta_3})\ \varepsilon_{si} \tag{2}$$

where *I* is innovative output, *IRD* is private corporate expenditures on R&D, *UR* is the research expenditures undertaken at universities, and *GC* measures the geographic coincidence of university and corporate research. The unit of observation for estimation was at the spatial level, *s,* a state, and industry level, *i*. Estimation of equation (2) essentially shifted the knowledge production function from the unit of observation of a firm to that of a geographic unit. Jaffee (1989) found empirical evidence that $\beta_1 \geq 0,\ \beta_2 \geq 0,\ \beta_3 \geq 0$ supports the notion of knowledge spills over for third-party use from university research laboratories as well as industry R&D laboratories. Acs, Audretsch and Feldman (1992) and Feldman (1994) confirmed that the knowledge production function represented by equation (2) held at a spatial unit of observation using a direct measure of innovative activity, new product introductions in the market. This was subsequently confirmed by Anselin, Acs and Varga (1997 and 2000).

Implicitly contained within the knowledge production function model is the assumption that innovative activity should take place in those regions, *s,* where the direct knowledge-generating inputs are the greatest, and where knowledge spillovers are the most prevalent. Jaffee (1989) dealt with the measurement problem raised by Krugman (1991) by linking the patent activity within technologies located within states to knowledge inputs located within the same spatial unit.

Thus, the empirical evidence suggests that location and proximity clearly matter in exploiting knowledge spillovers. Not only have Jaffe, Trajtenberg and Henderson (1993) found that patent citations tend to occur more frequently within the state in which they were patented than outside of that state, but Audretsch and Feldman (1996) found that the propensity of innovative activity to cluster geographically tends to be greater in industries where new economic knowledge plays a more important role. This effect was found to hold even after holding the degree of production at that location constant. Audretsch and Feldman (1996), follow Krugman's (1991) example, and calculate Gini coefficients for the geographic concentration of innovative activity to test this relationship. The results indicate that a key determinant of the extent to which the location of production is geographically concentrated is the relative importance of new economic knowledge in the industry. Even after controlling for the geographic concentration of production, the results suggest a greater propensity for innovative activity to cluster spatially in industries in which industry R&D, university research and skilled labor are important inputs. In this work, skilled labor is included as a mechanism by which knowledge spillovers may be realized as workers move between jobs in an industry taking their accumulated skills and know-how with them.

Zucker, Darby and Armstrong (1994) show that in biotechnology, which is an industry based almost exclusively on new knowledge, the firms tend to cluster together in just a handful of locations. This finding is supported by Audretsch and Stephan (1996) who examine the geographic relationships of scientists working with biotechnology firms. The importance of geographic proximity is clearly shaped by the role played by the scientist. The scientist is more likely to be located in the same region as the firm when the relationship involves the transfer of new economic knowledge. However, when the scientist is providing a service to the company that does not involve knowledge transfer, local proximity becomes much less important.

There is also reason to believe that knowledge spillovers are not homogeneous across firms. In estimating Equation (1) for large and small enterprises separately, Acs, Audretsch and Feldman (1994) provide some insight into the puzzle posed by the recent wave of studies identifying vigorous innovative activity emanating from small firms in certain industries. How are these small, and frequently new, firms able to generate innovative output while undertaking generally negligible amounts of investment into knowledge generating inputs, such as R&D? The answer appears to be through exploiting knowledge created by expenditures on research in universities and on R&D in large corporations. Their findings suggest that the innovative output of all firms rises along with an increase in the amount of R&D inputs, both in private corporations as well as in university laboratories. However, R&D expenditures made by private companies play a particularly important role in providing knowledge inputs to the innovative activity of large firms, while expenditures on research made by universities serve as an especially key input for generating innovative activity in small enterprises. Apparently large firms are more adept at exploiting knowledge created in their own laboratories, while their smaller counterparts have a comparative advantage at exploiting spillovers from university laboratories.

4. MOBILITY OF ECONOMIC AGENTS AS A SPILLOVER MECHANISM

The literature identifying mechanisms actually transmitting knowledge spillovers is sparse and remains underdeveloped. However, one important area where such transmission mechanisms have been identified involves entrepreneurship. Entrepreneurship involves the startup and growth of new enterprises. This mechanism for knowledge spillovers may not be the most dominant or even the most important. However, it is important to recognize that it may represent at least one mode by which spillovers of knowledge are transmitted.

Why should the mobility of economic agents serve as a mechanism for the spill over of knowledge from the source of origin? At least two major channels or mechanisms for knowledge spillovers have been identified in the literature. Both of these spillover mechanisms revolve around the issue of appropriability of new knowledge. Cohen and Levinthal (1989) suggest that firms develop the capacity to adapt new technology and ideas developed in other firms and are therefore able to appropriate some of the returns accruing to investments in new knowledge made externally. This view of spillovers is consistent with the traditional model of the knowledge production function, where the firm exists exogenously and then undertakes (knowledge) investments to generate innovative output.

By contrast, Audretsch (1995) proposes shifting the unit of observation away from exogenously assumed firms to individuals, such as scientists, engineers or other knowledge workers – agents with endowments of new economic knowledge. When the lens is shifted away from the firm to the individual as the relevant unit of observation, the appropriability issue remains, but the question becomes, *How can economic agents with a given endowment of new knowledge best appropriate the returns from that knowledge?* If the scientist or engineer can pursue the new idea within the organizational structure of the firm developing the knowledge and appropriate roughly the expected value of that knowledge, he has no reason to leave the firm. On the other hand, if he places a greater value on his ideas than do the decision-making bureaucracy of the incumbent firm, he may choose to start a new firm to appropriate the value of his knowledge. Small enterprises can compensate for their lack of R&D is through spillovers and spin-offs. Typically an employee from an established large corporation, often a scientist or engineer working in a research laboratory, will have an idea for an invention and ultimately for an innovation. Accompanying this potential innovation is an expected net return from the new product. The inventor would expect to be compensated for his/her potential innovation accordingly. If the company has a different, presumably lower, valuation of the potential innovation, it may decide either not to pursue its development, or that it merits a lower level of compensation than that expected by the employee.

In either case, the employee will weigh the alternative of starting his/her own firm. If the gap in the expected return accruing from the potential innovation between the inventor and the corporate decision maker is sufficiently large, and if the cost of starting a new firm is sufficiently low, the employee may decide to leave the large corporation and establish a new enterprise. Since the knowledge was generated in the established corporation, the new start-up is considered to be a spin-off from the existing firm. Such start-ups typically do not have direct access to a large R&D laboratory. Rather, these small firms succeed in exploiting the knowledge and experience accrued from the R&D laboratories with their previous employers.

The research laboratories of universities provide a source of innovation-generating knowledge that is available to private enterprises for commercial exploitation. Jaffe (1989) and Acs, Audretsch, and Feldman (1992), Audretsch and Feldman (1996) and Feldman and Audretsch (1999), for example, found that the knowledge created in university laboratories "spills over" to contribute to the generation of commercial innovations by private enterprises. Acs, Audretsch, and Feldman (1994) found persuasive evidence that spillovers from university research contribute more to the innovative activity of small firms than to the innovative activity of large corporations.

In the metaphor provided by Albert O. Hirschman (1970), if voice proves to be ineffective within incumbent organizations, and loyalty is sufficiently weak, a knowledge worker may resort to exit the firm or university where the knowledge was created in order to form a new company. In this spillover channel the knowledge production function is actually reversed. The knowledge is exogenous and embodied in a worker. The firm is created endogenously in the worker's effort to appropriate the value of his knowledge through innovative activity.

One group of studies has focused on how location has influenced the entrepreneurial decision, or the decision to start a new firm. Within the economics literature, the prevalent theoretical framework has been the general model of income choice. The model of entrepreneurial choice dates back at least to Knight (1921), but was more recently extended and updated by Lucas (1978), Kihlstrom and Laffont (1979), Holmes and Schmidtz (1990) and Jovanovic (1994). In its most basic rendition, individuals are confronted with a choice of earning their income either from wages earned through employment in an incumbent enterprise or else from profits accrued by starting a new firm. The essence of the entrepreneurial choice model is made by comparing the wage an individual expects to earn through employment, W*, with the profits that are expected to accrue from a new-firm startup, P*. Thus, the probability of starting a new firm, Pr(s), can be represented as

$$Pr(s) = f(P^{*} - W^{*}) \tag{3}$$

The model of entrepreneurial choice has been extended by Kihlstrom and Laffont (1979) to incorporate aversion to risk, and by Lucas (1978) and Jovanovic (1994) to explain why firms of varying size exist, and has served as the basis for empirical studies of the decision to start a new firm.

Audretsch and Stephan (1999) examined how the decision made by scientists to start a new biotechnology company is shaped by the experience trajectory of the scientist. They apply the framework of Stephan and Levin (1991) and Levin and Stephan (1991), which focuses on the incentive and reward structure facing scientists. This leads to the prediction that scientists from a trajectory involving employment in the private sector, typically a large pharmaceutical company, will have an incentive to start a company at a younger point in her career than her counterpart coming from an academic trajectory. In fact, the empirical evidence provides clear evidence that scientists from the academic trajectory start companies at a systematically older age than do their counterparts from pharmaceutical company trajectories.

Klepper (2002) finds evidence that companies started by the mobility involved in spin-offs from high performance automobile companies exhibited a higher level of performance than did companies started from entrepreneurs with experience in either low performance automobile companies or no experience at all in the automobile industry. He interprets his findings as suggesting that the learning process is superior in a high performance company, and that the spillover of knowledge is transmitted by the spin-off and startup of a new company.

Similarly, Audretsch and Lehman (2002) find compelling evidence that the trajectory and previous experience of board members also influences the performance of new firms. Based on a sample of high-technology and knowledge-intensive German startup companies, they find empirical evidence suggesting that the human capital of the board members has a positive impact on firm performance.

Geographic location should influence the entrepreneurial decision by altering the expected return from entrepreneurial activity, P*. The theory of knowledge spillovers suggests that P* will tend to be greater in agglomerations and spatial clusters, since access to tacit knowledge is greater. Geography and spatial location also influences entrepreneurship. The important role that geographic clusters and networks play as a determinant of entrepreneurial activity was identified in Europe and only recently has been discovered within the North American context (Porter, 1990 and 2000; Saxenien, 1994).

For example, in studying the entrepreneurial networks located in California's Silicon Valley, Saxenian (1990, pp. 96-97) describes the entrepreneurship capital of Silicon Valley, "It is not simply the concentration of skilled labor, suppliers and information that distinguish the region. A variety of regional institutions – including Stanford University, several trade associations and local business organizations, and a myriad of specialized consulting, market research, public relations and venture capital firms – provide technical, financial, and networking services which the region's enterprises often cannot afford individually. These networks defy sectoral barriers: individuals move easily from semiconductor to disk drive firms or from computer to network makers. They move from established firms to startups (or vice versa) and even to market research or consulting firms, and from consulting firms back into startups. And they continue to meet at trade shows, industry conferences, and the scores of seminars, talks, and social activities organized by local business organizations and trade associations. In these forums, relationships are easily formed and maintained, technical and market information is exchanged, business contacts are established, and new enterprises are conceived. This decentralized and fluid environment also promotes the diffusion of intangible technological capabilities and understandings."

By contrast, there is a longer and richer tradition of research linking entrepreneurship to spatial clusters and networks in Europe. However, most of these studies have been in social science fields other than economics. For example, Becattini (1990) and Brusco (1990) identified the key role that spatial clusters and networks play in promoting SMEs in Italy. While such networks and clusters were generally overlooked or ignored in North America, with publication of Saxenien's book, *Regional Advantage,* which documented how spatial networks generated entrepreneurial activity in Silicon Valley and Route 128 around Boston, it became clear and accepted that spatial agglomerations were also important in the North American context.

An important distinction between the European literature and studies and the emerging literature in North America was the emphasis on high technology and knowledge spillovers in the North American context. By contrast, the European tradition focused much more on the role of networks and clusters in fostering the viability of SMEs in traditional industries, such as textiles, apparel and metalworking. For example, seminal studies by Becattini (1990) and Brusco (1990) argue that small and new firms enjoy a high degree of stability when supported by networks in Italy. A rich literature has provided a compelling body of case studies, spanning the textile industries of northern Italy to the metal working firms of Baden Wuerttemberg, documenting the long-term viability and stability of small and new firms embedded in the so-called industrial districts of Europe. Examples of such industrial districts include Prato, Biella, Carpi and Castelgoffredo, which specialize in textile (coolants in Castelgoffredo); Vigevano, Montebellune and Montegranaro where shoes are manufactured (ski boots in Montebellune); Pesaro and Nogara which manufacture wooden furniture; Sassuolo where ceramic tiles are produced.

Brusco (1990) emphasizes the cooperation among network firms within an industrial district. Such cooperation presumably reduces any size-inherent disadvantages and improves the viability of small firms operating within the network. Grabher (1993) similarly argues that the social structure underlying industrial networks contributes to the viability of small firms that would otherwise be vulnerable if they were operating in an isolated context.

Feldman (2001) and Feldman and Francis (2001) examine the impact of agglomeration on entrepreneurship. In particular, they focus on the formation of clusters through entrepreneurship. Based on entrepreneurship and interviews with entrepreneurs to explore the development of an Internet and biotechnology cluster around Washington, D.C., Feldman (2001) and Feldman and Francis (2001) provide compelling evidence that clusters form not because resources are initially located in a particular region, but rather through the work of entrepreneurs. Early entrepreneurs locate their businesses in a region and adapt to the particularities of the location. As their businesses begin to thrive, resources such as money, networks, experts, and services arise in, and are attracted to, the region. With this infrastructure in place, more entrepreneurial ventures locate and thrive in the region, which ultimately may create a thriving cluster where none previously existed.

Sorenson and Stuart (2001) show that location matters in obtaining venture capital. By analyzing the determinants of venture capital investment in the United States between 1986 and 1998, they find that the likelihood of a venture capitalist investing in a given target declines with increasing geographical distance between the venture capitalist and the company.

Gompers and Lerner (1999) have shown how geography affects the location of venture capital. In particular, they show that the geographic distribution of venture capital is highly spatially skewed. Gompers and Lerner (1999) provide evidence showing California, New York, and New England as the major location of venture capital funds.

If the mobility of economic agents serves as a mechanism for knowledge spillovers, it should not only be reflected by the model of entrepreneurial choice, or the decision to start a new firm. Rather, measures reflecting the mobility of economic agents should also be positively linked to the growth performance of regions. The view of entrepreneurship that is based on its role as an agent of change in a knowledge-based economy implies that a positive economic performance should be linked to entrepreneurial activity. This hypothesis has raised two challenges to researchers: (1) What is meant by economic performance and how can it be measured and operationalized? and (2) Over which units of analysis should such a positive relationship between entrepreneurship and economic performance be manifested? In fact, these two issues are not independent from each other. The answer to the second question, the appropriate unit of analysis, has influenced the first question, the performance criteria and measure.

The most prevalent measures of performance has been employment growth. The most common and almost exclusive measure of performance is growth, typically measured in terms of employment growth. These studies have tried to link various measures of entrepreneurial activity, most typically startup rates, to economic growth. Other measures sometimes used include the relative share of SMEs, and self-employment rates.

For example, Audretsch and Fritsch (2002) analyzed a database identifying new business startups and exits from the social insurance statistics in Germany to examine whether a greater degree of turbulence leads to greater economic growth, as suggested by Schumpeter in his 1911 treatise. These social insurance statistics are collected for individuals. Each record in the database identifies the establishment at which an individual is employed. The startup of a new firm is recorded when a new establishment identification appears in the database, which generally indicates the birth of a new enterprise. While there is some evidence for the United States linking a greater degree of turbulence at the regional level to higher rates of growth for regions, Audretsch and Fritsch (2002) find that the opposite was true for Germany during the 1980s. In both the manufacturing and the service sectors, a high rate of turbulence in a region tends to lead to a lower and not a higher rate of growth. They attribute this negative relationship to the fact that the underlying components – the startup and death rates – are both negatively related to subsequent economic growth. Those areas with higher startup rates tend to experience lower growth rates in subsequent years. Most strikingly, the same is also true for the death rates.

Audretsch and Fritsch (2002) conjectured that one possible explanation for the disparity in results between the United States and Germany may lie in the role that innovative activity, and therefore the ability of new firms to ultimately displace the incumbent enterprises, plays in new-firm startups. It may be that innovative activity did not play the same role for the German *Mittelstand* as it does for SMEs in the United States. To the degree that this was true, it may be hold that regional growth emanates from SMEs only when they serve as agents of change through innovative activity.

The empirical evidence suggested that the German model for growth provided a sharp contrast to that for the United States. While Reynolds et al (1995) had found that the degree of entrepreneurship was positively related to growth in the United States, a series of studies by Audretsch and Fritsch (2002) could not identify such a relationship for Germany. However, the results by Audretsch and Fritsch were based on data from the 1980s.

Divergent findings from the 1980s about the relationship between the degree of entrepreneurial activity and economic growth in the United States and Germany posed something of a puzzle. On the one hand, these different results suggested that the relationship between entrepreneurship and growth was fraught with ambiguities. No confirmation could be found for a general pattern across developed countries. On the other hand, it provided evidence for the existence of distinct and different national systems. The empirical evidence clearly suggested that there was more than one way to achieve growth, at least across different countries. Convergence in growth rates seemed to be attainable by maintaining differences in underlying institutions and structures.

However, in a more recent study, Audretsch and Fritsch (2002) find that different results emerge for the 1990s. Those regions with a higher startup rate exhibit higher growth rates. This would suggest that, in fact, Germany is changing over time, where the engine of growth is shifting towards entrepreneurship as a source of growth. The results of their 2002 paper suggest a somewhat different interpretation. Based on the compelling empirical evidence that the source of growth in Germany has shifted away from the established incumbent firms during the 1980s to entrepreneurial firms in the 1990s, it would appear that a process of convergence is taking place between Germany and the United States, where entrepreneurship provides the engine of growth in both countries. Despite remaining institutional differences, the relationship between entrepreneurship and growth is apparently converging in both countries.

Audretsch and Keilbach (2002) and link the mobility of workers in general, and knowledge workers in particular, as it is manifested by the startup of new firms, to the output of German regions in the context of a production function model. Their results indicate that a higher degree of worker mobility and especially knowledge worker mobility that leads to a new-firm startup has a significant and positive impact on output and productivity growth.

5. CONCLUSIONS

Romer (1986), Lucas (1978 and 1992) and Grossman and Helpman (1992) established that knowledge spillovers are an important mechanism underlying endogenous growth. However, they shed little light on the actual mechanisms by which knowledge is transmitted across firms and individuals. The answer to this question is important, because a policy implication commonly drawn from the new economic growth theory is that, as a result of convexities in knowledge and the resultant increasing returns, knowledge factors, such as R&D should be publicly supported. While this may be valid, it is also important to recognize that the mechanisms for spillover transmission may also play a key role and may also serve as a focus for public policy enhancing economic growth and development. This paper proposes the mobility of economic agents from one economic context to a different economic context as one such channel transmitting spillovers.

There are at least two important implications arising from the view that the mobility of economic agents transmits the spillover of knowledge. The first is that the basic assumptions of the knowledge production view of the firm may, in fact, not hold, at least in knowledge-based industries. The knowledge production view assumes the firm exists exogenously and then invests in knowledge to endogenously generate innovative activity. This paper suggests a very different interpretation. Economic agents have an endowment of knowledge that can be considered to be exogenous at any moment of time. In order to appropriate the value of their knowledge they may remain in their current situation at an incumbent firm, or they may choose to leave that firm and go to a different enterprise, or even to start a new firm. In this case, the knowledge is exogenous and the new firm is endogenously created in an attempt to appropriate the value of knowledge. The mobility of economic agents with a knowledge endowment may not involve direct immediate commercialization, but rather movement to situations where the accumulation of knowledge capital is greater than in the status quo situation. Thus, the mobility of economic agents across different contexts and their creation of trajectories becomes an important mechanism for the process by which knowledge spills over from one context and organization to another.

The second implication may be that the propensity for economic agents to engage in mobility may not be constant across industries, regions and countries but is presumably shaped by contextual factors. These contextual factors, which Audretsch and Keilbach (2002) term as constituting entrepreneurship capital, may in fact, constitute a key missing factor in explaining variations in growth across geographic space. Those regions with a rich endowment of entrepreneurship capital would be expected to experience a relatively high degree of mobility among economic agents, which would consequently result in higher levels of economic performance. What exactly constitutes such entrepreneurship capital and how it impacts growth needs to be identified and analyzed in what promises to be a rich and rewarding line of scholarly research.

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