# The Knowledge Spillover Theory of Entrepreneurship and Economic Growth

**David B. Audretsch and Max Keilbach**

**Max Planck Institute of Economics**

## Abstract

According to the knowledge spillover theory of entrepreneurship, people start a new firm because they are not able to commercialize their ideas and knowledge within the context of an incumbent firm or organization. Entrepreneurship therefore serves as a conduit for the spillover of knowledge from the firm or organization where that knowledge was created to its commercialization in the organizational context of a new firm. Because it facilitates the spillover and commercialization of knowledge that might otherwise have remained dormant and uncommercialized within the incumbent firm generating that knowledge in the first place, entrepreneurship has a positive impact on economic growth.

## 1.Introduction

Where do new opportunities come from and what is the response of decision makers when confronted by such new opportunities? The disparate approaches pursued to answer to these questions distinguish the literature on entrepreneurship from that on firm innovation. The model of the knowledge production function of the firm has assumed the firm to be exogenous, while opportunities are endogenously created through purposeful investments in the creation of new knowledge, such as expenditures on research and development and augmentation of human capital.

By contrast, in the entrepreneurship literature the opportunities are generally viewed as exogenous but the startup of the new firm is endogeneous tocharacteristics specific to the individual. The focus of the entrepreneurship literature in general, and entrepreneurship theory in particular, has been on the cognitive process by which individuals recognize entrepreneurial opportunities and then decide to attempt to actualize them through the process of starting a new business or organization (Agarwal et al., 2008). This approach has typically taken the opportunities as given and focused instead on differences across individual-specific characteristics, traits and conditions to explain variations in entrepreneurial behavior. According to Bricklin (2001), “I suppose you could say the entrepreneurial instinct was in my genes.” Similarly, Hopkins concludes that, “Entrepreneurs like (Richard) Branson are born…From family, they

inhereit may traints key to entrepreneurship: creativity, drive, a willingness to take risks."[1]

The purpose of this paper is to reconcile these two disparate literatures on entrepreneurship and firm strategy. We do this by considering entrepreneurship to be endogenous – not just to differences in individual characteristics, but rather to differences in the context in which a given individual, with an endowment of personal characteristics, propensities and capabilities, finds herself.

We do not contest the validity of the pervasive entrepreneurship literature identifying individual specific characteristics as shaping the decision to become an entrepreneurial. What we do propose, however, is that such differences in the contexts in which any given individual finds herself, might also influence the entrepreneurial decision.

Rather than taking entrepreneurial opportunity as exogenous, this paper places it in the main center of attention by making it endogenous. Entrepreneurial opportunity is posited to be greater in contexts that are rich in knowledge but limited in those contexts with impoverished knowledge. According to the knowledge spillover theory of entrepreneurship, entrepreneurship is an endogenous response to investments in knowledge made by firms and non-private organizations that do not fully commercialize those new ideas, thus generating opportunities for entrepreneurs. Thus, while most of the literature typically takes entrepreneurial opportunities to be exogenous, this paper

[1] Jim Hopkins, "Entrepreneurs Are Born, but Can They be Taught?" *USA Today*, April 7.

suggests that they are, in fact, endogenous, and systematically created by investments in knowledge.

A summary and conclusions are provided in the last section. In contrast to the prevalent approach in entrepreneurship theory, knowledge spillover theory of suggests that entrepreneurial opportunities are not exogenous but rather systematically generated by investments in ideas and knowledge that cannot be fully appropriated and commercialized by those incumbent firms and organizations creating the new knowledge.

## 2. Where Does Opportunity Come From?

### 2.1 The Entrepreneurial Firm

Why do (some) people start firms? This question has been at the heart of considerable research, not just in economics, but throughout the social sciences. Herbert and Link (1989) have identified three distinct intellectual traditions in the development of the entrepreneurship literature. These three traditions can be characterized as the German Tradition, based on von Thuenen and Schumpeter, the Chicago Tradition, based on Knight and Schultz, and the Austrian Tradition, based on von Mises, Kirzner and Shackle.

Stevenson and Jarillo (1990) assume that entrepreneurship is an orientation towards opportunity recognition. Central to this research agenda are the questions, *"How do entrepreneurs perceive opportunities and how do these opportunities manifest themselves as being credible versus being an illusion?"* Kruger (2003) examines the nature of entrepreneurial thinking and the cognitive process associated with opportunity

identification and the decision to undertake entrepreneurial action. The focal point of this research is on the cognitive process identifying the entrepreneurial opportunity along with the decision to start a new firm. Thus, a perceived opportunity and intent to pursue that opportunity are the necessary and sufficient conditions for entrepreneurial activity to take place. The perception of an opportunity is shaped by a sense of the anticipated rewards accruing from and costs of becoming an entrepreneur. Some of the research focuses on the role of personal attitudes and characteristics, such as self efficacy (the individual's sense of competence), collective efficacy, and social norms. Shane (2000) has identified how prior experience and the ability to apply specific skills influence the perception of future opportunities. The concept of the entrepreneurial decision resulting from the cognitive processes of opportunity recognition and ensuing action is introduced by Shane and Eckhardt (2003) and Shane and Venkataraman (2001). They suggest that an equilibrium view of entrepreneurship stems from the assumption of perfect information. By contrast, imperfect information generates divergences in perceived opportunities across different people. The sources of heterogeneity across individuals include different access to information, as well cognitive abilities, psychological differences, and access to financial and social capital.

It is a virtual consensus that entrepreneurship revolves around the recognition of opportunities and the pursuit of those opportunities (Venkataraman, 1997). Much of the more contemporary thinking about entrepreneurship has focused on the cognitive process by which individuals reach the decision to start a new firm. According to Sarasvathy, Dew, Velamuri and Venkataraman (2003, p. 142), "An entrepreurial opportunity consists of a set of ideas, beliefs and actions that enable the creation of future goods and services

in the absence of current markets for them". Sarasvathy, Dew, Velamuri and Venkataraman provide a typology of entrepreneurial opportunities as consisting of opportunity recognition, opportunity discovery and opportunity creation.

In asking the question of why some do it, while others don't, scholars have focused on differences across individuals (Stevenson and Jarillo, 1990). As Krueger (2003, p. 105) observes, "The heart of entrepreneurship is an orientation toward seeing opportunities," which frames the research questions, "What is the nature of entrepreneurial thinking and What cognitive phenomena are associated with seeing and acting on opportunities?" The traditional approach to entrepreneurship essentially holds the context constant and then asks how the cognitive process inherent in the entrepreneurial decision varies across different individual characteristics and attributes (Shaver, 2003; McClelland, 1961). As Shane and Eckhardt (2003, p 187) summarize this literature in introducing the individual-opportunity nexus, "We discussed the process of opportunity discovery and explained why some actors are more likely to discover a given opportunity than others." Some of these differences involve the willingness to incur risk, others involve the preference for autonomy and self-direction, while still others involve differential access to scarce and expensive resources, such as financial capital, human capital, social capital and experiential capital. This approach focusing on individual cognition in the entrepreneurial process has generated a number of important and valuable insights, such as the contribution made by social networks, education and training, and familial influence. The literature certainly leaves the impression that entrepreneurship is a personal matter largely determined by DNA, familial status and access to crucial resources.

## 2.2 Opportunities Created by the Incumbent Firm

In contrast to the prevalent thinking concerning entrepreneurial startups, the most predominant theory of firm innovation does not assume that opportunities are exogenous to the firm. Rather, innovative opportunities are the result of systematic effort by firms and the result of purposeful efforts to create knowledge and new ideas, and subsequently to appropriate the returns of those investments through commercialization of such investments. Thus, while the entrepreneurship literature has taken entrepreneurial opportunities to be exogenous, the literature on firm innovation and technological change has taken the creation of such innovative opportunities to be endogenous.

The traditional starting point in the literature on innovation and technological change for most theories of innovation has been the firm (Chandler, 1989; Cohen and Levin 1989; and Griliches 1979). In such theories firms are exogenous and their performance in generating technological change is endogenous (Cohen and Klepper, 1991 and 1992).

The most prevalent model of technological change is the model of the knowledge production function, formalized by Zvi Griliches in 1979. According to the model of the knowledge production function, incumbent firms engage in the pursuit of new economic knowledge as an input into the process of generating the output of innovative activity. The most important input in this model is new economic knowledge. As Cohen and Klepper (1991 and 1992) point out, the greatest source generating new economic knowledge is generally considered to be R&D. Other inputs in the knowledge production

function have included measures of human capital, skilled labor, and educational levels. Thus, the model of the knowledge production function from the literature on innovation and technological change can be represented as

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

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.

Thus, in this view of firm innovation, the firm exists exogenously. It undertakes purposeful investments to create knowledge endogenously, which results in the output of innovative activity. Opportunities are not exogenous, but rather the result of purposeful and dedicated investments and efforts by firms to create new (knowledge) opportunities and then to appropriate them through commercializing their innovations.

There is considerable evidence suggesting that, in contrast to the findings for R&D inputs and patented inventions, small enterprises apparently play an important generating innovative activity, at least in certain industries. By relating the innovative output of each firm to its size, it is also possible to shed new light on the Schumpeterian Hypothesis. In their 1990 study, Acs and Audretsch find that there is no evidence that increasing returns to R&D expenditures exist in producing innovative output. In fact, with just several exceptions, diminishing returns to R&D are the rule. This study made it possible to resolve the apparent paradox in the literature that R&D inputs increase at more than a proportional rate along with firm size, while the generation of patented

inventions does not. That is, while larger firms are observed to undertake a greater effort towards R&D, each additional dollar of R&D is found to yield less in terms of innovative output.

The model of the knowledge production function therefore became less compelling in view of a wave of studies that found that small enterprises were an engine of innovative activity in certain industries. The apparent contradiction between the organizational context of knowledge inputs, principally R&D, and the organizational context of small firm innovative output resulted in the emergence of what has become known as the *Innovation Paradox*: 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 look beyond the boundaries of the firm for sources of innovative inputs.

## 3. The Knowledge Spillover Theory of Entrepreneurship

### 3.1 Endogenous Entrepreneurship

Resolution to the *Innovation Paradox* came after rethinking not the validity of the model of the knowledge production function, but rather the implicit assumptions of independence and separability underlying the decision-making analytical units of observation – the established incumbent firm and the new entrepreneurial firm. Just as the prevailing theories of entrepreneurship have generally focused on the cognitive process of individuals in making the decision to start a new firm, so that the decision making criterion are essentially internal to the decision-making unit – in this case the individual,

the model of the knowledge production function generally limited the impact of the firm's investments in creating new knowledge to that decision-making unit – in this case the firm.

That these decision-making units – the firm and the individual – might actually not be totally separable and independent, particularly with respect to assessing the outcome of knowledge investments, was first considered by Audretsch (1995), who introduced *The Knowledge Spillover Theory of Entrepreneurship*.

The reason for challenging the assumptions of independence and separability between (potential) entrepreneurs and firms emanates from a fundamental characteristic of knowledge that differentiates it from the more traditional firm resources of physical capital and (unskilled) labor. Arrow (1962) pointed out that knowledge differs from these traditional firm resources due to the greater degree of uncertainty, higher extent of asymmetries, and greater cost of transacting new ideas.

The expected value of any new idea is highly uncertain, and as Arrow pointed out, has a much greater variance than would be associated with the deployment of traditional factors of production. After all, there is relative certainty about what a standard piece of capital equipment can do, or what an (unskilled) worker can contribute to a mass-production assembly line. By contrast, Arrow emphasized that when it comes to innovation, there is uncertainty about whether the new product can be produced, how it can be produced, and whether sufficient demand for that visualized new product might actually materialize.

In addition, new ideas are typically associated with considerable asymmetries. In order to evaluate a proposed new idea concerning a new biotechnology product, the decision maker might not only need to have a PhD.in biotechnology, but also a specialization in the exact scientific area. Such divergences in education, background and experience can result in a divergence in the expected value of a new project or the variance in outcomes anticipated from pursuing that new idea, both of which can lead to divergences in the recognition and evaluation of opportunities across economic agents and decision-making hierarchies. Such divergences in the valuation of new ideas will become greater if the new idea is not consistent with the core competence and technological trajectory of the incumbent firm.

Thus, because of the conditions inherent in knowledge – high uncertainty, asymmetries and transactions cost – decision making hierarchies can reach the decision not to pursue and try to commercialize new ideas that individual economic agents, or groups or teams of economic agents think are potentially valuable and should be pursued. The basic conditions characterizing new knowledge, combined with a broad spectrum of institutions, rules and regulations impose what Acs et al. (2004) and Audretsch et al. (2006) termed as *The Knowledge Filter*. The knowledge filter is the gap between new knowledge and what Arrow (1962) referred to as economic knowledge or commercialized knowledge. The greater is the knowledge filter, the more pronounced is this gap between new knowledge and new economic, or commercialized, knowledge.

The knowledge filter is a consequence of the basic conditions inherent in new knowledge. Similarly, it is the knowledge filter that creates the opportunity for entrepreneurship in the knowledge spillover theory of entrepreneurship. According to this

theory, opportunities for entrepreneurship are the duality of the knowledge filter. The higher is the knowledge filter, the greater are the divergences in the valuation of new ideas across economic agents and the decision-making hierarchies of incumbent firms. Entrepreneurial opportunities are generated not just by investments in new knowledge and ideas, but in the propensity for only a distinct subset of those opportunities to be fully pursued by incumbent firms.

Thus, as Audretsch pointed out in 1995, the knowledge theory of entrepreneurship shifts the fundamental decision making unit of observation in the model of the knowledge production function 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, she has no reason to leave the firm. On the other hand, if she 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.

In the knowledge spillover theory of entrepreneurship 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. 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 knowledge worker would expect to be compensated for 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 knowledge worker will weigh the alternative of starting 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, the entrepreneurial opportunity emanates from the knowledge and experience accrued in the R&D laboratories with their previous employers. Thus the knowledge spillover view of entrepreneurship is actually a theory of endogenous entrepreneurship, where entrepreneurship is an endogenous response to opportunities created by investments in new knowledge in a given context that are not commercialized because of the knowledge filter.

The knowledge spillover theory of entrepreneurship posits that entrepreneurship is a response to investments in knowledge and ideas by incumbent organizations that are not fully commercialized by those organizations. Thus, those contexts that are richer in

knowledge will offer more entreperneurial opportunities and therefore should also endogenously induce more entrepreneurial activity, *ceteris paribus*. By contrast, those context that are impoverished in knowledge will offer only meager entrepreneurial opportunities generated by knowledge spillovers, and therefore would endogenously induce less entrepreneurial activity.

But what is the appropriate unit of observation to be used to frame the context and observe the entrepreneurial response to knowledge investments made by incumbent organizations? In his 1995 book, Audretsch proposed using the industry as the context in which knowledge is created, developed, organized and commercialized. The context of an industry was used to resolve the paradox concerning the high innovative output of small enterprises given their low level of knowledge inputs that seemingly contradicted the Griliches model of the firm knowledge production, "The findings in this book challenge an assumption implicit to the knowledge production function – that firms exist exogenously and then endogenously seek out and apply knowledge inputs to generate innovative output. ..It is the knowledge in the possession of economic agents that is exogenous, and in an effort to appropriate the returns from that knowledge, the spillover of knowledge from its producing entity involves endogenously creating a new firm" (pp. 179-180).

What is the source of this entrepreneurial knowledge that endogenously generated the startup of new firms? The answer seemed to be through the spillover of knowledge from the source creating to commercialization via the startup of a new firm, "How are these small and frequently new firms able to generate innovative output when undertaken a generally negligible amount of investment into knowledge-generating inputs, such as

R&D? One answer is apparently through exploiting knowledge created by expenditures on research in universities and on R&D in large corporations" (p. 179).

The empirical evidence supporting the knowledge spillover theory of entrepreneurship was provided from analyzing variations in startup rates across different industries reflecting different underlying knowledge contexts (Audretsch, 1995). In particular, those industries with a greater investment in new knowledge also exhibited higher startup rates while those industries with less investment in new knowledge exhibited lower startup rates, which was interpreted as the mechanism by which knowledge spillovers are transmitted.

In subsequent research, Klepper and Sleeper (2000) showed how spin-offs in the automobile industry exhibited a superior performance when the founder came from a high-performing incumbent firm, as compared to a low-performing incumbent firm, or even from outside of the industry. Klepper interpreted this result as indicating that the experience and ability to absorb human capital within the context of the incumbent firm influenced the subsequent entrepreneurial performance. Similar results were found for Agarwal et al. (2004).

Thus, compelling evidence was provided suggesting that entrepreneurship is an endogenous response to the potential for commercializing knowledge that has not been adequately commercialized by the incumbent firms. This involved an organizational dimension involving the mechanism transmitting knowledge spillovers – the startup of new firms.

### 3.2 A Model

The starting point for models of economic growth in the Solow tradition is that the rate of technical change, the rate with which new technological knowledge is created, is exogenous. This view has been challenged by the endogenous growth theory (Romer, 1986, 1990; Lucas, 1988). Consider the Romer (1990) growth model. The production function is expressed as

$$Y = K^{\alpha}(AL_Y)^{(1-\alpha)}, \tag{1}$$

where Y represents economic output, K is the stock of capital, $L_Y$ is the labor force in the production of Y, and A is the stock of knowledge capital. The capital accumulation function is standard from the Solow (1956) model:

$$\dot{K} = s_K Y - \Delta K, \tag{2}$$

where $s_K$ is the saving rate and $\Delta$ is the depreciation rate of capital. The R&D sector is modeled as

$$\dot{A} = \bar{\delta} L_A, \tag{3}$$

where $\bar{\delta}$ is the *discovery rate* of new innovations with

$$\bar{\delta} = \delta L_A^{1-\lambda} A^{\phi} \tag{4}$$

$L_A$ denotes the amount of labor active in the generation of new knowledge (such as R&D personnel), $\lambda$ denotes returns to scale in R&D, and $\phi$ is a parameter that

expresses the intensity of *knowledge spillovers*. Inserting (3.4) into (3.3), we obtain the rate of creation of new knowledge (the rate of endogenous technical change):

$$\dot{A} = \delta L_A^{\lambda} A^{\phi} \tag{5}$$

In the Romer, Lucas, and Jones models, knowledge automatically spills over and is commercialized, reflecting the Arrow observation about the nonexcludability and nonexhaustive properties of new knowledge. Thus, investment in R&D and human capital automatically affect output in a multiplicative manner because of their external properties, suggesting that new knowledge, A, is tantamount to commercialized economic knowledge $A_c$, that is, $A = A_c$.

As we discussed earlier, the emphasis on, or rather assumption about, the nonexcludability property is better suited for information than knowledge. Information has, by its definition, a very low level of uncertainty, and its value is not greatly influenced or shaped by asymmetries across economic agents possessing that information. Thus, information can be characterized as being nonexcludable and nonexhaustive. In contrast, as Arrow points out, there is a gap between new knowledge and what actually becomes commercialized, or new economic knowledge, $A - A_c > 0$. In fact, the knowledge filter is defined as the gap existing between investments in knowledge and the commercialization of knowledge, or economic knowledge. We denote the knowledge filter as θ, hence

$$\theta = A_c / A, \quad \text{with} \quad 0 \le A_c \le A \quad \text{hence} \quad \theta \in [0,1], \tag{6}$$

hence θ denotes the *permeability* of the knowledge filter. It is the existence of the knowledge filter, or knowledge not commercialized by incumbent enterprises, that generates the entrepreneurial opportunities for commercializing knowledge spillovers. As long as the incumbent enterprises cannot exhaust all of the commercialization opportunities arising from their investments in new knowledge, opportunities will be generated for potential entrepreneurs to commercialize that knowledge by starting a new firm. Thus, the actual level of new technological knowledge used by incumbent firms is

$$\dot{A}_c = \theta \cdot \delta L_A^{\lambda} A^{\phi}. \tag{7}$$

Correspondingly, the remaining "untapped" part (1−θ) is opportunities *opp* that can be taken on by new firms. We denote this part *entrepreneurial opportunities*. Thus, we have

$$\dot{A}_{opp} = (1-\theta)\dot{A} = (1-\theta) \cdot \delta L_A^{\lambda} A^{\phi}. \tag{8}$$

The observation that knowledge conditions dictate the relative advantages in taking advantage of opportunities arising from investments in knowledge of incumbents versus small and large enterprises is not new. Nelson and Winter (1982) distinguished between two knowledge regimes. What they call the routinized technological regime reflects knowledge conditions where the large incumbent firms have the innovative

advantage. In contrast, in the entrepreneurial technological regime, the knowledge conditions bestow an innovative advantage on small enterprises (Winter, 1984).

However, there are two important distinctions to emphasize. The first is the view that, in the entrepreneurial regime, the small firms exist and will commercialize the new knowledge or innovate. In the lens provided by the spillover theory of entrepreneurship, the new firm is endogenously created via entrepreneurship, or the recognition of an opportunity and pursuit by an economic agent (or team of economic agents) to appropriate the value of that knowledge. These knowledge-bearing economic agents use the organizational context of new firm creation to attempt to appropriate their endowments of knowledge.

The second distinction is that the knowledge will be commercialized, either by large or small firms. In the lens provided by the Knowledge Spillover Theory of Entrepreneurship, the knowledge filter impedes and preempts at least some of the knowledge spillover and commercialization of knowledge. Only select spillover mechanisms, such as entrepreneurship, can permeate the knowledge filter. But this is not a forgone conclusion; rather, the situation will vary across specific contexts and depends on a broad range of factor, spanning individual characteristics, institutions, culture, and laws, and is characterized by what we call in chapter 4 entrepreneurship capital. Thus, to merely explain entrepreneurship as the residual from $\dot{A}_{opp} = \dot{A} - \dot{A}_c$ assumes that all opportunities left uncommercialized will automatically result in the commercialized spillover of knowledge via entrepreneurship.

This was clearly not the case in the former Soviet Union and its Eastern European allies, just as, according to Annalee Saxenian, in *Regional Advantage* (1994), it was not the case for Silicon Valley or Route 128. That is, the capacity of each context, or Standort, to commercialize the residual investments in knowledge created by the knowledge filter through entrepreneurship is not identical. Rather, it depends on the capacity of that Standort to generate an entrepreneurial response that permeates the knowledge filter and creates a conduit for transmitting knowledge spillovers.

Both the West and the former Soviet Union invested in the creation of new knowledge. Both the West and the former Soviet Union innovated in what Nelson and Winter characterized as the routinized regime. The divergence in growth and economic performance emanated from differences in the knowledge filter and the ability to overcome that knowledge filter. Just as the West proved to have the institutional context to generate entrepreneurial spillovers and commercialize a far greater level of knowledge investment, so, too, as Saxenian documents, the organizational structure and social capital of Silicon Valley provided a more fertile context than Route 128 did for knowledge spillovers through entrepreneurship. Both Silicon Valley and Route 128 had the requisite knowledge inputs to generate innovative output. Saxenian´s main conclusion is that the differences between the two Standorts that resulted in a greater degree of knowledge spillovers and commercialization in Silicon Valley than in Route 128 were institutional. Thus, just as the knowledge filter should also not be assumed to be automatic. Rather, entrepreneurship, whether it emanates from opportunities from knowledge spillovers or from other sources, is the result of a cognitive process made by an individual within the institutional context of a particular Standort.

This cognitive process of recognizing and acting on perceived opportunities, emanating from knowledge spillovers as well as well as other sources, *E*, is characterized by the model of occupational (or entrepreneurial) choice, where *E* reflects the decision to become an entrepreneur, $\pi^*$ is the profit expected from starting a new firm, and *w* is the anticipated wage that would be earned from employment in an incumbent enterprise.

$$E = f(\pi^* - w). \tag{9}$$

But what exactly are the sources of these entrepreneurial opportunities based on expected profits accruing from entrepreneurship? As we said, most of the theoretical and empirical focus has been on characteristics of the individual, such as attitudes towards risk and access to financial capital and social capital. Thus, the entrepreneurial opportunities are created by variation in individual characteristics within a context held constant. Entrepreneurial opportunities are generated because individuals are heterogeneous, leading to variation in the ability of individuals to recognize opportunities and their willingness to act upon those opportunities. Thus, the focus on entrepreneurship, and why it varies across contexts, or Standorts, seemingly leads to the conclusion that individuals must differ across the different contexts.

In the view presented here, we invert this analysis. Instead of holding the context constant and asking how individuals endowed with different characteristics will behave differently, we take all of the characteristics of the individual, all of his or her various propensities, proclivities, and peculiarities, as given. We will let the context, or

Standort, in which he or she finds herself vary and then ask, Holding the (characteristics of the) individual constant, how will behavior change as the context changes?

Of course, guided by the Knowledge Spillover Theory of Entrepreneurship, we know that the contextual variation of interest is knowledge. We want to know whether and how, in principle, the same individual(s) with the same attributes, characteristics, and proclivities will be influenced in terms of the cognitive process of making the entrepreneurial choice, as the knowledge context differs. In particular, some context are rich in knowledge, while others are impoverished in knowledge. Does the knowledge context alter the cognitive process weighing the entrepreneurial choice?

According to the Knowledge Spillover Theory of Entrepreneurship, it will. We certainly do not claim that knowledge spillovers account for all entrepreneurial opportunities, or that any of the existing explanations of entrepreneurship are any less valid. The major contextual variable that has been previously considered is growth, especially unanticipated growth. Hence, we can rewrite equation (3.9) as

$$E = f\left( \pi^{*}\left[ g_{Y}, \dot{A}_{opp}, \theta \right] - w \right), \tag{10}$$

which states that the expected profits are based on opportunities that accrue from general economic growth, $g_{Y}$, on one hand and from potential knowledge spillovers, $\dot{A}_{opp}$, on the other. Therefore, the total amount of entrepreneurship can be decomposed

into knowledge spillover entrepreneurship, which is denoted as E*, and entrepreneurship from rather traditional sources, that is nonknowledge sources, such as growth $\overline{E}$, that is,

$$E = \overline{E} + E^{*}. \tag{11}$$

Economic growth that is anticipated by incumbent firms will be met by those firms as they invest to expand their capacity to meet expected growth opportunities. If, however, there is any type of constraint in expanding the capacity of incumbent enterprises to meet (unexpected) demand, then growth of GDP, $g_Y$, will generate entrepreneurial opportunities that have nothing to do with new knowledge, or

$$\overline{E} = f\left(\pi^{*}\left[g_Y\right] - w\right) \tag{12}$$

Let us distinguish this type of traditional entrepreneurship from the one based on opportunities from knowledge spillovers. As we claimed, investments in new knowledge in a given context will generate entrepreneurial opportunities. The extent of such entrepreneurial opportunities is shaped by two sources. The first is the amount of new knowledge being produced. The second is the permeability of the knowledge filter, which limits the commercialization of that new knowledge by the incumbent firms. If there were neither new knowledge nor ideas being generated, then there would be no spillover opportunities for potential entrepreneurs to consider. There might be entrepreneurship triggered by other factors, but not by knowledge opportunities. Similarly, in the absence of a knowledge filter, all opportunities for appropriating the value of that knowledge would be pursued and commercialized by incumbent firms. In this case, knowledge spillovers would be considerable, just not from entrepreneurship.

Thus, two factors shape the relative importance of knowledge spillover entrepreneurship: the amount of investment in creating new knowledge, $\dot{A}$, and the magnitude of the knowledge filter, $\theta$. Thus, knowledge spillover entrepreneurship, E*, is the attempt to appropriate profit opportunities accruing from the commercialization of knowledge not commercialized by the incumbent firms, or $1-\theta$,

$$E^* = f\left( \pi^*\left[ \dot{A}_{opp}, \theta \right] - w \right). \tag{13}$$

Equation (3.13) implicitly suggests that the only contextual influence on entrepreneurship emanating from knowledge spillovers is the extent of knowledge investments and permeability of the knowledge filter. Such a simple assumption neglects the basic conclusion from Saxenian (1994) that some contexts, such as Boston´s Route 128, have institutional and social barriers to entrepreneurship, while other contexts, such as Silicon Valley, have institutions and social networks that promote entrepreneurship. The exact nature of such impediments to entrepreneurship spans a broad spectrum of financial, institutional, and individual characteristics (Acs et al., 2005). Incorporating such impediments or barriers to entrepreneurship, β, yields

$$E^* = \frac{1}{\beta} f\left( \pi^*\left[ \dot{A}_{opp}, \theta \right] - w \right), \tag{14}$$

where β represents those institutional and individual barriers to entrepreneurship, spanning factors such as financing constraints, risk aversion, legal restrictions, bureaucratic and red tape constraints, labor market rigidities, lack of social acceptance, and so on (Acs et al., 2005). Although we do not explicitly specify these individual entrepreneurial barriers, we duly note that they reflect a wide range of institutional and

individual characteristics, which, taken together, constitute barriers to entrepreneurship. The existence of such barriers, or a greater value of β, explains why economic agents choose not to become entrepreneurs, even when endowed with knowledge that would otherwise generate a potentially profitable opportunity though entrepreneurship.

Since E > E*, the total amount of entrepreneurial activity exceeds that generated by knowledge spillovers. Thus, we also restate equation (10):

$$E = \frac{1}{\beta} f\left( \pi^* \left[ g_Y, \dot{A}_{opp}, \theta \right] - w \right) \tag{15}$$

Equation (15) and the corresponding discussion lead to the following propositions:

*Entrepreneurial Opportunities Proposition:* Entrepreneurship will be greater in regions with a greater amount of nonknowledge entrepreneurial opportunities, such as growth.

*Barriers to Entrepreneurship Proposition:* Entrepreneurship will be lower in regions burdened with barriers to entrepreneurship.

On the basis of the arguments given above, we can derive a number of hypotheses concerning the determinants of entrepreneurship and its impact on economic performance. The first hypothesis to emerge from the Knowledge Spillover Theory of Entrepreneurship is the following:

> *Endogenous Entrepreneurship Hypothesis:* Entrepreneurship will be greater in the presence of higher investments in new knowledge, ceteris paribus. Entrepreneurial activity is an endogenous response to higher investments in new knowledge, reflecting greater entrepreneurial opportunities generated by knowledge investments.

This hypothesis is consistent with the growth model. Equation (8) describes the generation of new opportunities. Investments in new knowledge are denoted $L_A$ within the model. Deriving (3.8) with respect to $L_A$, we obtain

$$\frac{d\dot{A}_{opp}}{dL_A} = (1-\theta)\cdot\delta\lambda L_A^{\lambda-1}A^{\phi}, \tag{16}$$

which is positive for all $L_A$ and $A^{\phi}$. Hence, opportunities increase with investment in new knowledge. Again, these hypotheses are consistent with the formal model given, Deriving (3.8) with respect to $A^{\phi}$ we obtain

$$\frac{d\dot{A}_{opp}}{dA^{\phi}} = (1-\theta)\cdot\delta L_A^{\lambda}, \tag{17}$$

which is positive for all $L_A$. Hence, opportunities increase with spillovers and therefore firms will locate near the source of spillovers ceteris paribus, which suggests this hypothesis:

> *Economic Performance Hypothesis:* Entrepreneuial activity will increase the level of economic output since entrepreneurship serves as a mechanism facilitating the spillover and commercialization of knowledge.

On the basis of the arguments given, we state production function (3.1) as

$$Y = K^{\alpha}(\theta_r A)^{(1-\alpha)}L_Y^{(1-\alpha)}, \tag{18}$$

where $\theta_r$ denotes the *realized permeability* of the knowledge filter, that is, that level that includes the part of $(1-\theta)$ that has been taken on by startup firms. Thus, we have $\theta_r \in [0,1-\theta]$ or $\theta \le \theta_r \le 1$. An increase in entrepreneurial activity increases $\theta_r$ and therefore the distance between $\theta$ and $\theta_r$. Deriving

$$\frac{dY}{d\theta_r} = (1-\alpha)\theta_r^{-\alpha}K^{\alpha}A^{(1-\alpha)}L_Y^{(1-\alpha)} = \frac{1-\alpha}{\theta_r}Y, \tag{19}$$

which is greater than 0 for all Y, thus, economic output, or GDP, increase with entrepreneurial activity.

The third hypothesis emerging from the Knowledge Spillover Theory of Entrepreneurship concerns the location of the entrepreneurial activity. Access to knowledge spillovers requires spatial proximity. Though Jaffe (1989) and Audretsch and Feldman (1996) showed that spatial proximity is a prerequisite to accessing such knowledge spillovers, they provided no insight about the actual mechanism transmitting such knowledge spillovers. As for Romer, Lucas, and Jones models, the Jaffe (1989) and Audretsch and Feldman (1999) studies assume that investment in new knowledge automatically generates knowledge spillovers. The only additional insight involves the spatial dimension – knowledge spills over but these spillovers are spatially bounded. Since we have identified just one such mechanism by which knowledge spillovers are transmitted – the startup of a new firm – it follows that knowledge spillover entrepreneurship is also spatially bounded in that local access is required to access the knowledge facilitating the entrepreneurial startup:

> *Localization Hypothesis:* Knowledge spillover entrepreneurship will tend to be spatially located within close geographic proximity to the source of knowledge actually producing that knowledge.

One of the important findings of Glaeser et al. (1992) and Feldman and Audretsch (1999) is that economic performance is improved by knowledge spillovers. However, their findings, as well as corroborative results from a plethora of studies, focused on a spatial unit of observation, such as cities, regions, and states. For example, Glaeser et al. (1992) found compelling empirical evidence suggesting that a greater degree of knowledge spillover leads to greater economic growth rates of cities. If higher knowledge

spillovers bestow higher growth rates for cities, this relationship should also hold for the unit of observation of the knowledge firm.

## 7. Conclusions

Something of a dichotomy has emerged between the literatures on entrepreneurial opportunities and firm innovation and technology management. On the one hand, in the entrepreneurship literature, opportunities are taken as being exogenous to the fundamental decision-making unit – the individual confronted with an entrepreneurial decision. On the other hand, in the model of the knowledge production function opportunities are decidedly endogenous and the result of purposeful investments into the creation of new knowledge and ideas through expenditures on research and development and augmentation to human capital. This dichotomy between the literatures on firm innovation and entrepreneurship reflects implicit assumptions about the independence and separability of the two essential decision-making units – the incumbent organization and the (potential) entrepreneur.

This paper has drawn on emerging theories of entrepreneurship that challenge the assumption that opportunities are exogenous. The *Knowledge Spillover Theory of Entrepreneurship* inverts the assumptions inherent in the Model of the Knowledge Production Function for the firm. Rather than assuming that the firm is exogenous and then endogenously creates new knowledge and innovative output through purposeful investments in R&D and human capital, this view instead starts with an individual exogenously endowed with a stock of knowledge and ideas. The new firm is then

endogenously created in an effort to commercialize and appropriate the value of that knowledge.

The prevalent and traditional theories of entrepreneurship have typically held the context constant and then examined how characteristics specific to the individual impact the cognitive process inherent in the model of entrepreneurial choice. This often leads to the view that is remarkably analogous to that concerning technical change in the Solow (1956) model – given a distribution of personality characteristics, proclivities, preferences and tastes, entrepreneurship is exogenous. One of the great conventional wisdoms in entrepreneurship is "*Entrepreneurs are born not made*". Either you have it or you don't. This leaves virtually no room for policy or for altering what nature has created.

This chapter has presented an alternative view. We hold the individual attributes constant and instead focus on variations in the context. In particular, we consider how the knowledge context will impact the cognitive process underlying the entrepreneurial choice model. The result is a theory of endogenous entrepreneurship, where (knowledge) workers respond to opportunities generated by new knowledge by starting a new firm. In this view entrepreneurship is a rationale choice made by economic agents to appropriate the expected value of their endowment of knowledge. Thus, the creation of a new firm is the endogenous response to investments in knowledge that have not been entirely or exhaustively appropriated by the incumbent firm.

In the endogenous theory of entrepreneurship, the spillover of knowledge and the creation of a new, knowledge-based firm are virtually synonymous. Of course, there are

many other important mechanisms facilitating the spill over of knowledge that have nothing to do with entrepreneurship, such as the mobility of scientists and workers, and informal networks, linkages and interactions. Similarly, there are certainly new firms started that have nothing to do with the spillover of knowledge. Still, the spillover theory of entrepreneurship suggests that there will be additional entrepreneurial activity as a rationale and cognitive response to the creation of new knowledge. Those contexts with greater investment in knowledge should also experience a higher degree of entrepreneurship, ceteris paribus. Perhaps it is true that entrepreneurs are made. But more of them will discover what they are made of in a high-knowledge context than in an impoverished knowledge context. Thus, we are inclined to restate the conventional wisdom and instead propose that entrepreneurs are not necessarily made, bur are rather a response – and in particular a response to high knowledge contexts that are especially fertile in spawning entrepreneurial opportunities.

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