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A theoretical analysis of the role of social networks in entrepreneurship

By: Dennis P. Leyden, Albert N. Link, Donald S. Siegel

Leyden, D. P., Link, A. N., & Siegel, D. S. (2014). A theoretical analysis of the role of social networks in entrepreneurship. *Research Policy*, 43(7), 1157-1163. DOI: 10.1016/j.respol.2014.04.010

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Abstract:

Entrepreneurship involves innovation and uncertainty. We outline a theory of entrepreneurship, which highlights the importance of social networks in promoting innovation and reducing uncertainty. Our findings suggest that this “social” aspect of entrepreneurship increases the probability of entrepreneurial success. The results also lend credence to theories of entrepreneurship that suggest that entrepreneurial opportunities are formed endogenously by the entrepreneurs who create them. We also consider the public policy implications of our findings.

Keywords: Entrepreneurship | Social networks | Innovation | Technology

Article:

1. Introduction

Economists, sociologists, and management scholars have proposed numerous definitions of entrepreneurship (Hébert and Link, 2006), as well as different conceptual frameworks of the entrepreneurial process (Zahra and Wright, 2011). Shane and Venkataraman (2000) asserted that the study of entrepreneurship was hampered by the lack of a conceptual framework, with the primary failing being the lack of a definition of the entrepreneur who was process-oriented rather than simply descriptive. To address that failing, they proposed that the study of entrepreneurship be defined as “the study of sources of opportunities; the processes of discovery, evaluation, and exploitation of opportunities; and the set of individuals who discover, evaluate, and exploit them.” (p. 218). In a follow up article, Shane (2013) reflects on the state of the entrepreneurship literature for more than a decade following that critique, and he concludes that while debates continue there has been a convergence around their notion of what constitutes the study of entrepreneurship. This paper fits within that framework as well.

Based on these definitions and frameworks, we can identify two common characteristics of an entrepreneur: (1) an individual who embraces uncertainty and (2) an individual who is an innovator. The notion of an entrepreneur embracing uncertainty emanates from the early works of Cantillon (1931). Cantillon (1931, pp. 47−49) asserted that the farmer/entrepreneur decides how to allocate his land among various uses, "without being able to foresee which of these will pay best." He also noted that, due to vagaries of weather and demand, "the price of the farmer's produce depends naturally upon these unforeseen circumstances, and consequently he conducts the enterprise of his farm at an uncertainty."

The concept of the entrepreneur as an innovator traces to the writings of Baudeau ([1767] 1910). Within an agricultural setting, Baudeau conceived of the entrepreneur as an innovator, in the sense that he/she invents and applies new techniques or ideas in order to reduce costs. However, many attribute the entrepreneurial characteristic of innovativeness to the work of Joseph Schumpeter. The entrepreneur as innovator is most clearly articulated in his *Theory of Economic Development* (1934) and echoed in his subsequent writings. Schumpeter defined innovation in several ways: the creation of a new good or new quality of good, the creation of a new method of production; the opening of a new market, and the capture of a new source of supply.

Given these two important characteristics of an entrepreneur, we conjecture that the entrepreneurial process involves innovation that occurs within the context of an environment of uncertainty.

The purpose of this paper is to advance a theory of entrepreneurship that incorporates both of these ideas, yet also considers the importance of the social context. Our model is based on the notion that an entrepreneur is searching for knowledge and that key to the acquisition of knowledge is access to social networks. When the entrepreneur acquires more knowledge, there is a greater probability that his/her innovative activity will be successful. Our notion of the entrepreneur's search for knowledge in social networks parallels Granovetter's (1973) notion of weak ties and what some entrepreneurship scholars have referred to as the social dimension of context (e.g., Hoang and Antoncic, 2003, Welter, 2011 and Zahra and Wright, 2011).[1]

The notion that social networks are, in the words of Granovetter (1973, p. 1378), "no luxury but of central importance" has important implications both for public policy as well as for the management of the research process by individual firms. In particular, it suggests that emphasis should be placed on nurturing the entrepreneur's ability to exploit social networks through what Burt (2005) terms brokerage and closure, that is, the bringing together of heterogeneous social ties to form social networks and the facilitating of the coordination of those networks for the purpose of innovation.

The remainder of the paper is organized as follows: In Section 2, we outline our theory of entrepreneurship in a heuristic manner. The technical elements of our model are described in mathematical terms in Appendix A. Our model shows that for the entrepreneur, the probability of

a successful innovation is positively correlated with the size of the region to be searched for knowledge. The entrepreneur's ability to increase the size of the region to be searched depends on the expansiveness and heterogeneity of his/her effective social network. This social network yields experiential knowledge, which complements the innovation process.

In the concluding section of the paper, we reflect on Zahra and Wright's (2011) claim that the link between entrepreneurship and economic growth could be strengthened by implementing public policies that strengthen the entrepreneur's knowledge base. We also further develop the policy implications of our theoretical results. Finally, we comment on how social networks affect the classic debate (e.g., Alvarez and Barney, 2007) regarding the discovery vs. creation views of entrepreneurial opportunities.

2. A theoretical model of the entrepreneurial process

The innovation process is inherently uncertain. An entrepreneur identifies the desired innovation and then engages in an exploratory process of discovery to develop that innovation. The notion of uncertainty is that identified by Knight (1921), and anticipated by Cantillon (1931); i.e., a circumstance in which possible outcomes and their probabilities cannot be determined through deductive or empirical inductive analysis. This is in contrast to risk in which the future may not be known, but outcomes and probabilities can be determined through such methods.

Given such uncertainty, the identification of the desired innovation, as well as the conduct of the exploration process, will be based on the entrepreneur's subjective expectations. Knight (1921) observed that the source of these subjective probabilities of success is intuition, that is, the result of the entrepreneur's (often non-conscious) reflections is based on direct experience and knowledge of the experiences of others.[2] Knight also observed that through experience, entrepreneurs may bundle experiences to form their subjective probability estimates. To the extent that such subjective probability estimates become stable or are shared by others, they may come to be viewed as objective. Nonetheless, these estimates are by their very nature subjective, though in terms of explaining *ex ante* plans, this distinction may not matter; but, the distinction is certainly relevant for *ex post* outcomes. Indeed, Knight argued that it is differences between expected and eventual outcomes that provide the source of entrepreneurial return. Were expectations objective, the entrepreneurial process would, albeit with risk, be predetermined; the process would simply be one of production amenable to usual market processes and devoid of the potential for entrepreneurial return. This distinction between risk and uncertainty is thus crucial in understanding the entrepreneurial process.

As Nelson and Winter (1977) argued, the approach of treating innovation within a neoclassical equilibrium production context, even if couched in terms of known risks and risk aversion misses the point. The problem of understanding innovation and entrepreneurship is fundamentally about uncertainty and not about definable risk. Thus, any analysis that seeks to provide insight and

guidance must accept a “diversity and disequilibrium of choices” (p. 47), that is, an analysis in which decisions *ex ante* cannot be evaluated as being correct or incorrect.

We characterize the process of discovery as a two-step process of problem formulation and search within and across sources of knowledge. Nelson and Winter (1977, pp. 52–53) describe this set of heuristics that essentially embody an R&D search strategy as a “set of procedures for identifying, screening, and honing in on promising ways to get to [an] objective.” The ability of the entrepreneur to search within and across sources of knowledge is determined by the size and heterogeneity of his/her effective networks; the greater the heterogeneity of social ties and past knowledge and experiences, the more creative will be the entrepreneur.

2.1. The sequential decision-making process[3]

The entrepreneur's decision making process is a costly one, which is developed sequentially against a background of social and professional experiences as well as resource constraints. If we begin with the choice of the desired innovation already in place, we can conceive of the entrepreneur's efforts as being focused on the exploration of various combinations of knowledge, actions, and resources thought to have a reasonable chance of yielding the desired innovation. For ease of exposition we refer to possible knowledge, actions, and resources as “inputs.” Sequentially, then, the entrepreneur searches over time for a combination of inputs that will generate the desired innovation. If success—achieving the desired innovation—is not achieved initially, the entrepreneur widens the range of inputs over which to explore. This search process is illustrated by Fig. 1 for the case of two inputs, x_1 and x_2. Initially the entrepreneur begins with the relatively small search region, $\mathcal{A}_1$. If success is not achieved exploring in that initial search region, the entrepreneur expands to a larger region, $\mathcal{A}_2$, and continues to search. This process of ever widening search regions continues until success is achieved or until the entrepreneur decides it is no longer desirable to continue to search.

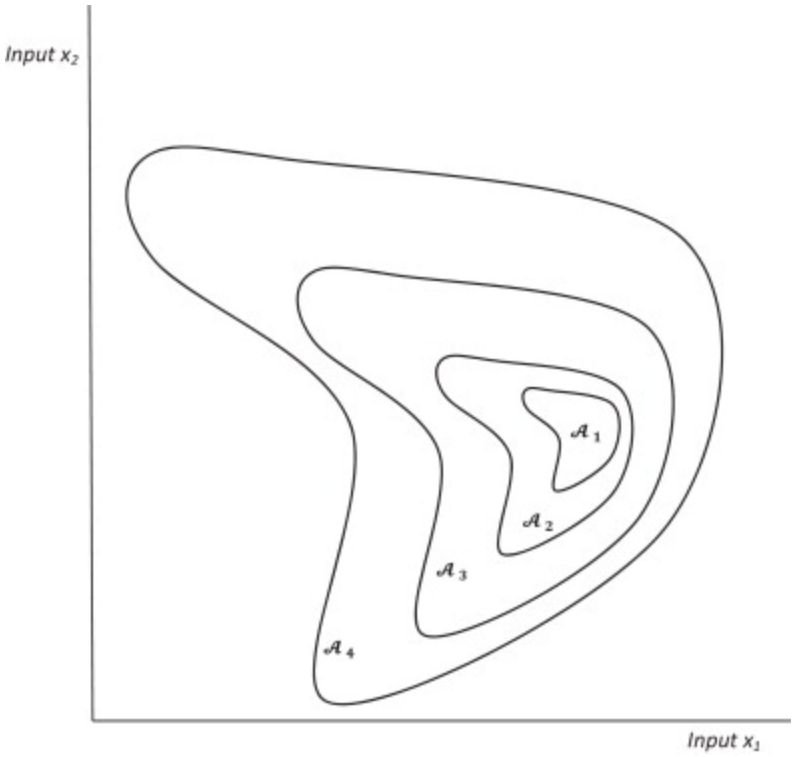

Fig. 1. Regions of entrepreneurial search among knowledge, actions, and resources ("inputs").

If searching were costless, the entrepreneur would continue to search until success was achieved. However, searching is a costly process. We assume that this cost, c(A|γ), increases as the size, *A*, of the search region increases, and decreases with the effectiveness of the entrepreneur's networks, γ. The effectiveness of the entrepreneur's network, γ, is assumed to be a positive function of the heterogeneity of the entrepreneur's social ties and past experiences (i.e., the entrepreneur's social network). [4] Indeed, social capital and social networks have been found to be important determinants of entrepreneurship at various levels of aggregation (e.g., Stuart and Sorenson, 2005 and Kwon and Arenius, 2010). [5]

Since the innovation process is uncertain, the entrepreneur's choice of where to search will be determined by subjective estimates of the probability of success.[6] Given a search region, $\mathcal{A}$, of a given size, *A*, the entrepreneur will choose the boundaries of that search so as to maximize the subjective probability of success. Thus, we can define the probability of success of a region of size *A* by the cumulative probability function $\bar{F}(A|\mathcal{K})$, with $\mathcal{K}$ representing the accumulated knowledge of all types relevant to the desired innovation process—engineering and scientific knowledge, knowledge of the entrepreneurial process acquired directly through experience and indirectly acquired via interaction and observation of others.

2.2. The entrepreneur's resource constraint

Entrepreneurial activity also requires financial capital. While self-funding is common, many entrepreneurs eventually secure funding through private equity (e.g., Wright, 2013 and Link et al., 2014). We assume that the entrepreneur's access to financial capital is constrained by the subjective expected value of the project,*Ve*, where that expected value can be defined as the product of the ultimate value, V , of the project (itself an expectation) were it to succeed and the probability of success $\bar{F}(A|\mathcal{K})$. Note that *Ve* is not necessarily measured solely in monetary terms, though to the extent capital is raised externally, the possibility that *Ve* will include non-monetary components is less likely. Note also that if the entrepreneur is unable to appropriate fully the benefits from the innovation, this maximum value will be lower. Thus, the entrepreneur will be constrained by the requirement that the cost, c(A|γ), of the innovation process not exceed the expected value *Ve* of the project. Our concept of cost includes the cost of failure.

2.3. The solution to the entrepreneur's problem

The entrepreneur is assumed to maximize the probability of success of his/her innovative activity. We conjecture that this is a reasonable assumption because when entrepreneurs are asked about motivation and success, they usually respond that it requires passion. Streitfeld (2012) has found that when an entrepreneur's focus is restricted to a monetary payoff, the result is typically failure. Thus, we hypothesize that the entrepreneur's objective is to choose a region of size *A* that will maximize the probability of success, subject to the resource constraint. [7] Moreover, because increasing the size of a search region increases the probability of success, the resource constraint will always hold as an equality. That is, the entrepreneur's expected cost, c(A|γ), will always equal the expected value, *Ve*, of the project.

To represent this solution graphically, note that the condition that expected cost equal the expected value of the project is equivalent to the condition that the average cost of the project, c(A|γ)/A, equal the average value of the project, Ve/A, both averages being calculated with respect to the size of the search region. Thus, the solution to the entrepreneur's problem can be illustrated by point E_1 in Fig. 2 given the level of the entrepreneur's effective network is γ_1.

Finally, note that an increase in the level of the entrepreneur's effective network to γ_2, where $\gamma_2 > \gamma_1$, will result in a decrease in the average costs to $c(A|\gamma_2)/A$. And, this decrease in average cost will increase the optimal search region size to A_2^* , and thereby increase the probability of successfully achieving the desired innovation.

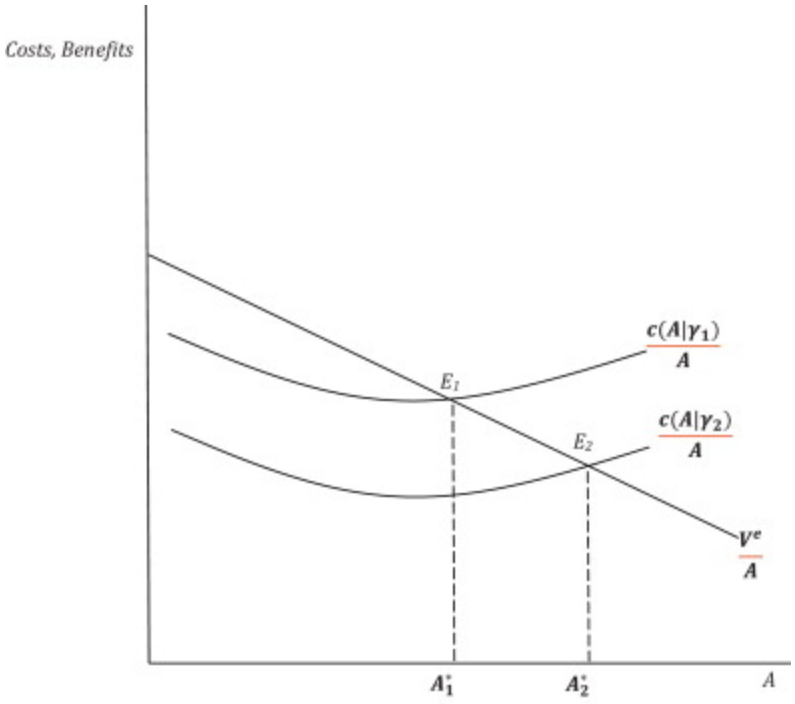

Fig. 2. Optimal solution to the entrepreneur's problem.

3. Managerial and policy implications of the role of social networks in innovation and entrepreneurship

While characterized in a variety of ways, we have explored the nature of entrepreneurship based on the arguments that can be traced back to the works of Baudeau ([1767] 1910), Cantillon (1931), and Schumpeter (1934). Based on this research, we conclude that an entrepreneur is an individual who innovates within the context of an uncertain environment. Given that characterization, this paper has argued that key to entrepreneurial success is the ability of the entrepreneur to exploit social networks (represented in our model by γ), which Granovetter (1973) terms weak ties.

Note that our theory implies that it is not so much knowledge, K per se, but rather effective social networks, γ, (and the variety of knowledge that such networks imply) that affect the probability of success in yielding the desired innovation. As a result, managerial and public policies that are directed at increasing levels of technical skill—a form of knowledge, K —in a particular area will not increase the probability of achieving the desired innovation. Rather, policies should be considered that are directed to increasing the heterogeneity of sources of knowledge that the entrepreneur relies on. These policies might take a variety of forms but will in general be characterized by what Burt (2005) refers to as brokerage and closure. In the educational community, this might be achieved through curricula that result in greater knowledge across disparate perspectives and an ability (and willingness) to work with

individuals with disparate perspectives—thus, for example, pairing disparate areas of study, focusing collectively on science, technology, engineering, and mathematics (i.e., STEM education), and teaching group management skills. Similarly, outside of the educational community this might be achieved by facilitating the creation of entrepreneurial teams with heterogeneous backgrounds (what might be referred to as entrepreneurial joint ventures), fostering joint ventures among private-sector firms (e.g., Hagedoorn et al., 2000 and Audretsch and Feldman, 2003), and fostering joint ventures between/among entrepreneurs and universities or research labs (e.g., Stiglitz and Wallsten, 1999, Agrawal, 2001, OECD, 2002, Poyago-Theotoky et al., 2002,McMillan and Hamilton, 2003, Hall, 2004 and Mowery and Nelson, 2004).

Some industries, most notably science-intensive sectors such as the pharmaceutical, biotechnology, and chemical industries, are already heavily engaged in collaborative research joint ventures (Faulkner and Senker, 1994, Klevorick et al., 1995 and Cohen et al., 2002). As a result, public policies that involve the allocation of resources (as opposed to public policies such as the Bayh-Dole Act (Stevens, 2004) that focus on stimulating the social networking through changes in the legal or institutional environment) are likely to most effective if they concentrate on those sectors (such as food, medical equipment, and metals; see Cohen et al., 2002) that are not currently heavily engaged in collaborative research joint ventures but have potential for gains in that regard. Leyden and Link (2013) provide (in the context of university-industry collaborative research joint ventures) an analysis of the effect of alternative joint venture structures on the type of firm that will choose to participate.

Academic entrepreneurship (Grimaldi et al., 2011) provides an interesting example in which social networks have been found to be especially important in fostering innovation and entrepreneurship. Three key academic studies of academic entrepreneurship—Lockett et al. (2003), Niclaou and Birley (2003), and Mustar et al. (2006)—report that a key determinant of a university's ability to generate startups is the vastness of its academic social networks. These papers build on earlier quantitative and qualitative studies conducted by prominent sociologists and economists (e.g., Powell, Zucker, Darby, Owen-Smith), and several of their former graduate students and post-docs on the importance of social networks in academic entrepreneurship (e.g., Powell et al., 1996, Siegel et al., 2001, Zucker and Darby, 2001, Owen-Smith and Powell, 2001 and Owen-Smith and Powell, 2003).[8]

It is also important to note that the nature of university-industry relationships assumes many forms (e.g., consultancy and contract research, joint research, training, licensing, etc.) (Wright et al., 2008). Some of these forms are more conducive (such as joint research) to fostering social networks than others (such as licensing). To that extent, policies that focus on those relationships that are more network enhancing would be of greater value. See Perkmann and Walsh (2007). In developing such policies, it is important to take account of the incentives for both the private sector firm and for the university. Thus, for example, research partnerships are generally more

attractive to university faculty members than research service contracts (Boyer and Lewis, 1984). See Leyden and Link (2013) for a more general analysis of the relationship between industry and universities and the need to take account of motivations on both sides. [9]

It is recognition of the value of academic social networks that has led to national and to state-local policies directed at attracting star academic scientists, especially those who have a strong entrepreneurial orientation, in order to stimulate academic entrepreneurship.[10] Hiring a star scientist potentially secures access to that scientist's social network (that is, the scientist's brokerage and closure skills), which could have large implications both in terms of the vibrancy of the entrepreneurial process as well as in terms of attracting additional financial support for additional research and commercialization. However, as with any entrepreneurial endeavor, there are no guarantees of success. While academic scientists have much to offer the entrepreneur, they too have their limitations, often times associated with a lack of knowledge of the commercialization part of the entrepreneurial process. Indeed, it is because of concerns about the lack of commercialization expertise on the part of academics (among other reasons) that universities have established technology transfer offices.[11]

Another important implication of our analysis is that due to the dynamics of networking, successful innovators and entrepreneurs need more than good ideas, sufficient resources, an outstanding business plan, and intelligence. They need to have a Kirznerian alertness, not only to opportunities in terms of outcomes, but also with whom they work (that is, the formation of their social networks) and how they manage that network.[12] Clearly, part of that ability to effectively manage social networks is the ability to be perceived positively within those networks. Leading entrepreneurship scholars (e.g., Stuart and Sorenson, 2005) have found that social networks are especially important in the start-up process at universities because these networks include graduate students, post-doctoral researchers, current and former colleagues and associates who can provide advice, expertise, and also possibly, access to financial capital. From an empirical perspective, Kirznerian alertness and the ability to manage social networks may be difficult to observe directly. However, some key observable personal characteristics that appear to be associated with such abilities include variables such as the level of education, previous entrepreneurial experience, age, involvement in patenting, and (for academics) faculty status (e.g., Perkmann and Walsh, 2007).

Finally, our results have important implications for the classic debate among entrepreneurship scholars regarding whether entrepreneurial opportunities are created or discovered (e.g., Sarasvathy et al., 2003). Our results appear to lend credence to theories of entrepreneurship that suggest that entrepreneurial opportunities are formed endogenously by the entrepreneurs who create them (e.g., Alvarez and Barney, 2007). That is, the social network constitutes a mechanism for the entrepreneur to create and exploit such opportunities.

Appendix A.

The individual entrepreneur's decision making process is a costly one that plays out sequentially against a background of social and professional experiences as well as resource constraints. Given a desired innovation, the entrepreneur's efforts focus on exploring various combinations of knowledge, actions, and resources (hereafter “inputs”) thought to have a reasonable chance of producing the innovation. Let *N* be the total number of possible inputs so that input sets can be represented by $N \times 1$ vectors x∈ℝN (some entries in the vectors perhaps being zero).

The search for a combination of inputs ***x*** that will generate the desired outcome is assumed to take place sequentially over time. Letting $\mathcal{A}_t \in \mathbb{R}^N$ represent the region of the input space explored in time *t*, the entrepreneur searches over increasing large regions. Thus:

$\mathcal{A}_0 \subset \mathcal{A}_1 \subset \mathcal{A}_2 \subset \cdots$ equation(A1)

Searching is a costly process. Assume that this cost is a positive function of the size of the region explored and a negative function of the degree γ to which the entrepreneur has the ability to engage in creative cognition, and assume that the effectiveness of the entrepreneur's networks, γ, is a positive function of the heterogeneity of the entrepreneur's social ties and past experiences, *s*, that is, of the entrepreneur's social context:

equation(A2)

$$\gamma = \gamma(s) \ni \frac{d\gamma}{ds} > 0.$$

Letting *At* be the Lebesgue measure (that is, the size) of region $\mathcal{A}_t$:

$$A_t = A(\mathcal{A}_t) = \int_{x \in \mathcal{A}} x\,dx$$ equation(A3)

we can define the cost of searching as:

ct=c(At|γ) equation(A4)

Assume that these costs are characterized by (weakly) rising marginal costs and convex average costs with respect to *At*:

$$\frac{\partial c}{\partial A_t} > 0, \quad \frac{\partial^2 c}{\partial A_t^2} \geq 0$$ equation(A5)

$$\frac{c(A_t|\gamma)}{A_t} \ni A\frac{\partial^2 c}{\partial A_t^2} - 2\frac{\partial c}{\partial A_t} + 2\frac{c}{A_t} > 0$$ equation(A6)

and that an increased level of the effectiveness of the entrepreneur's networks results in a fall in total cost, marginal cost, and therefore average cost:

$$\frac{\partial c}{\partial \gamma} < 0, \quad \frac{\partial^2 c}{\partial A_t \partial \gamma} < 0, \quad \text{and} \quad \frac{1}{A_t}\frac{\partial c}{\partial \gamma} < 0$$ equation(A7)

Because the entrepreneurial process is an uncertain one, the probability of success in a given region $\mathcal{A}_t$ is objectively unknown. As a result, the entrepreneur is guided by subjective estimates of the probability of success. Letting the individual's knowledge set be some M-dimensional set $\mathcal{K} \in \mathbb{R}^M$, the entrepreneur's subjective probability of success in region $\mathcal{A}_t$ can then be defined by the cumulative probability function $F(\mathcal{A}_t|\mathcal{K})$. Given the pattern of search regions described by Eq. (A1), this cumulative probability will increase as the entrepreneur widens the search region. Thus:

$$F(\mathcal{A}_t|\mathcal{K}) \quad \ni \quad 0 \le F(\mathcal{A}_t|\mathcal{K}) \le 1 \quad \text{and} \quad F(\mathcal{A}_t|\mathcal{K}) < F(\mathcal{A}_{t+1}|\mathcal{K})$$ equation(A8)

Note that because the cost of searching increases with the size of the search region, the entrepreneur has an incentive given any *At* to define the associated $\mathcal{A}_t$ so as to maximize $F(\mathcal{A}_t|\mathcal{K})$. As a result the *At* is uniquely associated with $F(\mathcal{A}_t|\mathcal{K})$, and so we can redefine the cumulative probability function as:

$$\bar{F}(\mathcal{A}_t|\mathcal{K}) \quad \ni \quad 0 \le \bar{F}(\mathcal{A}_t|\mathcal{K}) \le 1 \quad \text{and} \quad \bar{F}(\mathcal{A}_t|\mathcal{K}) < \bar{F}(\mathcal{A}_{t+1}|\mathcal{K})$$ equation(A9)

To fund the innovation process, assume that the entrepreneur uses capital markets. As a result, the entrepreneur's access to capital is constrained by the expected value of the project *Ve* where that value can be defined as the product of the ultimate value V of the project were it to succeed (itself an expectation) and the probability of success $\bar{F}(\mathcal{A}_t|\mathcal{K})$:

$$V^e(V, A_t|\mathcal{K}) = V \cdot \bar{F}(\mathcal{A}_t|\mathcal{K})$$ equation(A10)

Thus, the entrepreneur's resource constraint will be:

$$c(A_t|\gamma) \le V^e(V, A_t|\mathcal{K})$$ equation(A11)

The solution to the entrepreneur's problems depends on what the objective of the entrepreneur is. We assume that the objective of the entrepreneur is to maximize the probability of successfully innovating. Thus, the entrepreneur's objective is to choose a region of size A^* that will maximize the probability $\bar{F}(\mathcal{A}_t|\mathcal{K})$ of success in achieving the desired entrepreneurial outcome subject to the budget constraint(A11). Because increasing the size of a search region, *At*, will always increase the aggregate probability of success (recall Eq. (A9)), the resource constraint (A11) will always hold as an equality:

$$c(A_t|\gamma) = V^e(V, A_t|\mathcal{K})$$ equation(A12)

which is equivalent to the condition that average cost is equal to the average value of searching:

$$\frac{c(A_t|\gamma)}{A_t} = \frac{V^e(V, A_t|K)}{A_t}$$ equation(A13)

Note that the outcomes noted above are *ex ante*. In practice, the entrepreneur engages in a sequential process of exploration. If it finds success before the search area reaches A^*, it will stop searching, and profits *ex post* will be higher than expected. If it does not find success after having searched the region A^*, it will stop searching, and profits *ex post* will be lower than expected, and in fact, will be negative. [13]

References

Agrawal, A., 2001. University-to-industry knowledge transfer: literature review and unanswered questions. International Journal of Management Reviews 3, 285–302.

Alvarez, S.A., Barney, J., 2007. Discovery and creation: alternative theories of entrepreneurial action. Strategic Entrepreneurship Journal 1, 11–26.

Audretsch, D.B., Feldman, M.P., 2003. Small-firm strategic research partnerships: the case of biotechnology. Technology Analysis and Strategic Management 15, 273–288.

Baudeau, N., 1910. In: Dubois, A. (Ed.), Première introduction à la philosophie Économique. P. Geuthner, Paris.

Bercovitz, J., Feldman, M.P., 2008. Academic entrepreneurs: organizational change at the individual level. Organization Science 19, 69–89.

Boyer, C.M., Lewis, D.R., 1984. Faculty consulting: responsibility or promiscuity? Journal of Higher Education 55, 637–659.

Bradley, S.R., Hayter, C.S., Link, A.N., 2013. Models and methods of university technology transfer. Foundations and Trends in Entrepreneurship 9, 365–570.

Burt, R.S., 2005. Brokerage and Closure: An Introduction to Social Capital. Oxford University Press, Oxford.

Cantillon, R., 1931. In: Higgs, H. (Ed.), Essai sur la nature du commerce en général. Macmillan, London.

Cohen, W.M., Nelson, R.R., Walsh, J.P., 2002. Links and impacts: the influence of public research on industrial R&D. Management Science 48, 1–23.

Faulkner, W., Senker, J., 1994. Making sense of diversity: public–private sector research linkage in three technologies. Research Policy 23, 673–695.

Fiet, J.O., Patel, P.C., 2008. Entrepreneurial discovery as constrained, systematic search. Small Business Economics 30, 215–229.

Granovetter, M.S., 1973. The strength of weak ties. TheAmerican Journal of Sociology 78, 1360–1380.

Grimaldi, R., Kenney, M., Siegel, D.S., Wright, M., 2011. 30 years after Bayh-Dole: reassessing academic entrepreneurship. Research Policy 40, 1045–1057.

Hagedoorn, J., Link,A.N.,Vonortas, N.S., 2000. Research partnerships. Research Policy 29, 567–586.

Hall, B.H., 2004. University-industry research partnerships in the United States. In: Contzen, J.-P., Gibson, D., Heitor, M.V. (Eds.), Rethinking Science Systems and Innovation Policies, Proceedings of the 6th International Conference on Technology Policy and Innovation. Purdue University Press, Purdue, IN http://elsa.berkeley.edu/∼bhhall/papers/BHH04 Kansai.pdf

Hébert, R.F., Link, A.N., 2006. The entrepreneur as innovator. Journal of Technology Transfer 31, 589–597.

Hoang, H., Antoncic, B., 2003. Network-based research in entrepreneurship. Journal of Business Venturing 18, 165–187.

Kirzner, I.M., 1985. Discovery and the Capitalist Process. University of Chicago Press, Chicago.

Klevorick, A.K., Levin, R.C., Nelson, R.R., Winter, S.G., 1995. On the sources and significance of interindustry differences in technological opportunities. Research Policy 24, 185–205.

Knight, F.H., 1921. Risk, Uncertainty, and Profit. Houghton Mifflin, Boston. Kwon, S.-W., Arenius, P., 2010. Nations of entrepreneurs: a social capital perspective. Journal of Business Venturing 25, 315–330.

Leyden, D.P., Link, A.N., 2013. Knowledge spillovers, collective entrepreneurship, and economic growth: the role of universities. Small Business Economics 41, 797–817.

Link, A.N., Ruhm, C.J., Siegel, D.S., 2014. Private equity and the innovation strategies of entrepreneurial firms: empirical evidence from the Small Business Innovation Research program. Managerial and Decision Economics, http://dx.doi.org/10.1002/mde.2648.

Lockett, A., Wright, M., Franklin, S., 2003. Technology transfer and universities' spinout strategies. Small Business Economics 20, 185–201.

McMillan, G.S., Hamilton, R.D., 2003. The impact of publicly funded basic research: an integrative extension of Martin and Salter. IEEE Transactions on Engineering Management 50, 184–191.

Mowery, D.C., Nelson, R.R., 2004. Ivory Tower and Industrial Innovation: University Industry Technology Before and After the Bayh-Dole Act. Stanford University Press, Palo Alto.

Mustar, P., Renault, M., Colombo, M.G., Piva, E., Fontes, M., Lockett, A., Wright, M., Clarysse, B., Moray, N., 2006. Conceptualizing the heterogeneity of research-based spin-offs: a multi-dimensional taxonomy. Research Policy 35, 289–308.

Nabseth, L., Ray, G.F., 1974. The Diffusion of New Industrial Processes: An International Study. Cambridge University Press, New York.

Nelson, R.R., Winter, S.G., 1977. In search of useful theory of innovation. Research Policy 6, 36–76.

Niclaou, N., Birley, S., 2003. Social networks in organizational emergence: the university spinout phenomenon. Management Science 49, 1702–1725.

Organization for Economic Co-operation and Development (OECD), 2002. Benchmarking Industry–Science Relationships. OECD Publishing, Paris.

Owen-Smith, J., Powell, W.W., 2001. To patent or not: faculty decisions and institutional success at technology transfer. Journal of Technology Transfer 26, 99–114.

Owen-Smith, J., Powell, W.W., 2003. The expanding role of university patenting in the life sciences: assessing the importance of experience and connectivity. Research Policy 32, 1695–1711.

Perkmann, M., Walsh, K., 2007. University–industry relationships and open innovation: towards a research agenda. International Journal of Management Reviews 9, 259–280.

Poyago-Theotoky, J., Beath, J., Siegel, D.S., 2002. Universities and fundamental research: reflections on the growth of university–industry partnerships. Oxford Review of Economic Policy 18, 10–21.

Powell, W.W., Koput, K.W., Smith-Doerr, L., 1996. Inter-organizational collaboration and the locus of innovation: networks of learning in biotechnology. Administrative Science Quarterly 41, 116–145.

Sarasvathy, S.D., Venkataraman, S., Dew, N., Velamuri, R., 2003. Three views of entrepreneurial opportunity. In: Acs, Z., Audretsch, D.B. (Eds.), The Handbook of Entrepreneurship Research. Kluwer, Dordrecht, pp. 141–160.

Schumpeter, J., 1934. The Theory of Economic Development. (R. Opie, Trans.). Harvard University Press, Cambridge (Translated from 2nd German edition. Originally published 1912).

Shalley, C.E., Perry-Smith, J.E., 2008. The emergence of team creative cognition: the role of diverse outside ties, sociocognitive network centrality, and team evolution. Strategic Entrepreneurship Journal 2, 23–41.

Shane, S., 2013. Reflections on the 2010 AMR Decade Award: delivering on the promise of entrepreneurship as a field of research. Academy of Management Review 37, 10–20.

Shane, S., Venkataraman, S., 2000. The promise of entrepreneurship as a field of research. Academy of Management Review 25, 217–226.

Siegel, D.S., Thursby, J.G., Thursby, M.C., Ziedonis, A.A., 2001. Organizational issues in university-industry technology transfer: an overview of the symposium issue. Journal of Technology Transfer 26, 5–11.

Siegel, D.S., Veugelers, R., Wright, M., 2007. Technology transfer offices and commercialization of university intellectual property: performance and policy implications. Oxford Review of Economic Policy 23, 640–660.

Stevens, A.J., 2004. The enactment of Bayh-Dole. Journal of Technology Transfer 29, 93–99.

Streitfeld, D., 2012. As boom lures app creators, tough part is making a living. New York Times http://www.nytimes.com/2012/11/18/business/as-boom-lures-app-creators-tough-part-is-making-a-living.html

Stiglitz, J.E., Wallsten, S.J., 1999. Public–private technology partnerships: promises and pitfalls. American Behavioral Scientist 43, 52–73.

Stuart, T., Sorenson, O., 2005. Social networks and entrepreneurship. In: Alvarez, S.A., Agarwal, R., Sorenson, O. (Eds.), Handbook of Entrepreneurship Research: Disciplinary Perspectives. Springer, New York, pp. 233–251.

Ward, T.B., Smith, S.M., Finke, R.A., 1999. Creative cognition. In: Sternberg, J. (Ed.), Handbook of Creativity. Cambridge University Press, Cambridge, pp. 189–212.

Wasserman, N., 2012. The founders dilemmas (Podcast). ECorner: Stanford University's Entrepreneurship Corner http://ecorner.stanford.edu/authorMaterialInfo.html?mid=2995

Welter, F., 2011. Contextualizing entrepreneurship: conceptual challenges and ways forward. Entrepreneurship Theory and Practice 35, 165–178.

Wessner, C.W., Wolff, A.W. (Eds.), 2012. Rising to the Challenge: U.S. Innovation Policy for the Global Economy. National Academies Press, Washington, DC.

Wright, M., 2013. Private equity: managerial and policy implications. Academy of Management Perspectives 27, 1–6.

Wright,M., Clarysse, B., Lockett,A.,Knockaert,M., 2008.Mid-range universities' linkages with industry: knowledge types and the role of intermediaries. Research Policy 37, 1205–1223.

Zahra, S.A., Wright, M., 2011. Entrepreneurship's next act. Academy of Management Perspectives 25, 67–83.

Zerbinati, S., Souitaris, V., 2007. Entrepreneurship in the public sector: a framework of analysis in European local governments. Entrepreneurship and Regional Development 17, 43–64.

Zucker, L.G., Darby, M.R., 2001. Capturing technological opportunity via Japan's star scientists: evidence from Japanese firms' biotech patents and products. Journal of Technology Transfer 26, 37–58.