Ideation, entrepreneurship, and innovation

By: Albert N. Link

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Abstract:

In this his paper I discuss the origins of ideas starting with Locke. I do this to motivate the question: Why do scholars of entrepreneurship, innovation, and enterprise dynamics need to know about the sources of ideas that lead to new technology and innovation. I suggest and illustrate an answer to this question as well: One might want to think about the source of ideas if one seeks a perspective, theoretical or empirical, about covariates with successful R&D-based activities.

Keywords: technology | innovation | entrepreneurship | R&D | research joint venture

Article:

Introduction

The origin of ideas is clearly an important topic to be addressed by eminent disciplinary scholars and then debated, and then debated yet again. Even addressing the narrower topic of the origin of entrepreneurial or innovative ideas is a bold if not presumptuous undertaking. For this, I set the stage with a brief summary statement of how two historical scholars viewed the sources of ideas and then I move to a brief discussion about what academic researchers in the field of entrepreneurship and innovation know about the sources that influence innovative behavior. In the final segment of this academic overview, I present some inaugural findings from my own research in this area, or more accurately, the research on which I have just begun to embark. I conclude at a point perhaps at which I should have begun: Why do scholars of entrepreneurship, innovation, and enterprise dynamics, like those assembled here, need to know about the sources of ideas that lead to new technology and innovation.

Antecedents of entrepreneurship

Let me begin with some observations by the English philosopher and so-called Father of Classical Liberalism, John Locke (1623–1704). He wrote in *An Essay Concerning Human Understanding*, one's experiences—good experiences as well as bad experiences—form the genesis for one's ideas.

> All ideas come from sensation or reflection. Let us then suppose the mind to be, as we say, white paper, void of all characters, without any ideas: How comes it to be furnished? Whence comes it by that vast store which the busy and boundless fancy of man has painted on it with an almost endless variety? Whence has it all the materials of reason and knowledge? To this I answer, in one word, from EXPERIENCE. In that all our knowledge is founded; and from that it ultimately derives itself. Our observation employed either, about external sensible objects, or about the internal operations of our minds perceived and reflected on by ourselves, is that which supplies our understandings with all the materials of thinking. These two are the fountains of knowledge, from whence all the ideas we have, or can naturally have, do spring. (Locke 1979, p. 59)

Given my audacity to distill Locke's insight into one sentence, and assuming that the distillation is just, I am not sure that many would disagree that experiences do influence one's mindset and thus possibly one's ideas.

David Hume (1711–1776), the Scottish philosopher and economists, refined, Locke's ideas about the experiential genesis of ideas. In *An Enquiry Concerning Human Understanding*, Hume referred to experiences in terms of impressions, feelings, and sensations.

> So we can divide the mind's perceptions into two classes, on the basis of their different degrees of force and liveliness. The less forcible and lively are commonly called 'thoughts' or 'ideas'. The others have no name in our language or in most others, presumably because we don't need a general label for them except when we are doing philosophy. Let us, then, take the liberty of calling them 'impressions', using that word in a slightly unusual sense. By the term 'impression', then, I mean all our more lively perceptions when we hear or see or feel or love or hate or desire or will. These are to be distinguished from ideas, which are the fainter perceptions of which we are conscious when we reflect on our impressions. … Put in philosophical terminology: all our ideas or more feeble perceptions are copies of our impressions or more lively ones. Here are two arguments that I hope will suffice to prove this. When we analyse our thoughts or ideas—however complex or elevated they are—we always find them to be made up of simple ideas that were copied from earlier feelings or sensations. Even ideas that at first glance seem to be the furthest removed from that origin are found on closer examination to be derived from it. (Hume 1993, pp. 7–8)

Moving from these classical philosophers to, in my opinion, some of the bold thinkers in our field, let me capsulize a few relevant points of T. W. Schultz and Fritz Machlup.

Schultz (1975) bridged the connection between ideas and entrepreneurship in terms of the connection between knowledge and education.

> Our knowledge of a person's abilities consists of inferences drawn from his performance. An ability is thus perceived as the competence and efficiency with which particular acts are performed. … There are various classes of abilities; they include the ability: (1) to learn, (2) to do useful work, (3) to play, (4) to create something, and (5) specifically for the purpose at hand, to deal with economic disequilibria. Since what is done can be

> observed, it is convenient to assume that the observed performance is related to a specific ability. Although these various classes undoubtedly overlap and interact, it is useful to proceed with qualifications as if each class has a special set of attributes. (Schultz 1975, p. 828)

There is enough evidence to give validity to the hypothesis that the ability to deal successfully with economic disequilibria is enhanced by education and that this ability is one of the major benefits of education accruing to people privately in a modernizing economy. (Schultz 1975, p. 843)

The connection between Schultz and my thoughts are that "to create something" reflects and idea and "to deal with economic disequilibria" reflects an entrepreneurial response to an opportunity, perhaps even an opportunity created by the idea. And, as Schultz makes clear, "the ability to deal … with disequilibria is enhanced by education."

But, Schultz was well aware that these connections are neither linear nor smooth; addressing them is merely "the first step on what appears to be a long new road" (1975, p. 843). This new road is sure to contain many potholes and detours.

However, Machlup (1980), among others, filled in some of the potholes and turned the detours into purposeful redirections. He argued that formal education is only one source of knowledge; knowledge is also gained experientially and at different rates by different individuals. Individuals can accrue knowledge from their day-to-day experiences which "will normally induce reflection, interpretations, discoveries, and generalizations …" (Machlup 1980, p. 179). Moreover, the cost of acquiring knowledge is related to differential abilities[1]:

> Some alert and quick-minded persons, by keeping their eyes and ears open for new facts and theories, discoveries and opportunities, perceive what normal people of lesser alertness and perceptiveness, would fail to notice. Hence new knowledge is available at little or no cost to those who are on the lookout, full of curiosity, and bright enough not to miss their chances." (Machlup 1980, p. 179)

Moving from the so-called antecedents of entrepreneurship—experiences that influence one's ability to perceptive an opportunity—to one of the consequences of entrepreneurship—one's actions on that perception is what defines one as being innovative—scholars have taken less of a philosophical and more of a pragmatic perspective.

Consequences of entrepreneurship

For example, Mansfield and Wagner (1975) looked at factors associated with successful industrial R&D projects. They suggested that an understanding of the genesis of the R&D idea might be relevant for understanding the success of the R&D.[2] Namely, they wrote that one might expect the probability of technical completion of an R&D project, the probability of

[1] More recently, Fernald and Jones (2014, p. 4) built on this idea: "New ideas come from an idea production function that depends on the number of people looking for new ideas as well as on the existing stock of ideas."
[2] See Link and Wright (2015) for a discussion and analysis of the failure of R&D projects.

commercialization of the resulting technology, and the economic success of the innovation in the market to be influenced by "the extent to which the firm's R&D portfolio is based on ideas coming from the R&D department, as distinct from the marketing department and other parts of the firm" (Mansfield and Wagner 1975, p. 184).[3]

Nearly two decades later, Cohen et al. (2002) studied the contribution of university and government labs (i.e., public research) on industrial (i.e., manufacturing) innovation.[4] Framing their study were the findings from the 1994 Carnegie Mellon Survey on Industrial R&D. Focusing on information sources (i.e., ideas), they found that the relatively more important information sources to learn about public research that were important to the conduct of industrial R&D were as follows: publications and reports (41.2 % of those in industrial R&D said this source was moderately or very important), informal interactions (35.6 % so reported), and meetings and conferences (35.1 % so reported).[5]

Entrepreneurial ideas that lead to a research collaboration

Turing to a new project that I have undertaken, let me discuss the origin of ideas that lead firms to form a research collaboration with other firms. The goal of such an entrepreneurial endeavor—called a research joint venture (RJV)—is the development of a new or improved technology or even an innovation.

My research interest in RJVs was spurred by the legislative discussions that eventually led to the passage of the National Cooperative Research Act (NCRA) of 1984 (Public Law 98–462).[6] Like others, I was interested in the passage of the act in terms of how it might affect both the level of private-sector R&D expenditures as well as the effectiveness of those investments. Soon after its passage, the US National Science Foundation (NSF) funded me to study RJVs in detail, or at least the specific RJVs that had been formed to date. Much of that initial work was later published as *Cooperative Research in U.S. Manufacturing: Assessing Policy Initiatives and Corporate Strategies* (Link and Bauer 1989).

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[3] I am using the term *technology* to refer to the application of new knowledge, learned through science or even R&D, to some practical problem, and I am using the term *innovation* to refer to a technology put into use or commercialized.

[4] Two examples that illustrate the genesis of an R&D idea and the success of the resulting R&D are in Link (1998) and in Hall et al. (2001).

[5] For an example of the importance publication citations, see Di Guardo et al. (2012).

[6] The act defined a "joint research and development venture" as: "The term 'joint research and development venture' means any group of activities, including attempting to make, making, or performing a contract, by two or more persons for the purpose of—(A) theoretical analysis, experimentation, or systematic study of phenomena or observable facts, (B) the development or testing of basic engineering techniques, (C) the extension of investigative findings or theory of a scientific or technical nature into practical application for experimental and demonstration purposes, including the experimental production and testing of models, prototypes, equipment, materials, and processes, (D) the collection, exchange, and analysis of research information, or (E) any combination of the purposes specified in subparagraphs (A), (B), (C), and (D), and may include the establishment and operation of facilities for the conducting of research, the conducting of such venture on a protected and proprietary basis, and the prosecuting of applications for patents and the granting of licenses for the results of such venture…".

Beginning in 1993 and continuing through 2008, NSF graciously supported my development and maintenance of what became known as the Cooperative Research (CORE) database.[7]

As part of the NCRA, an RJV benefits by registering their venture with the US Department of Justice (DoJ); the DoJ then published those filings in the *Federal Register*.[8] The filings in the *Federal Register* became the population of US RJVs for inclusion in the CORE database; that is, the unit of observation in the CORE database is the RJV itself. As well, the CORE database became what might be viewed as the national database for tracking collaborative firm-with-firm research activities.[9] Figure 1 shows the number of RJVs formed since the passage of the NCRA and its subsequent amendments by year of disclosure in the *Federal Register*.[10]

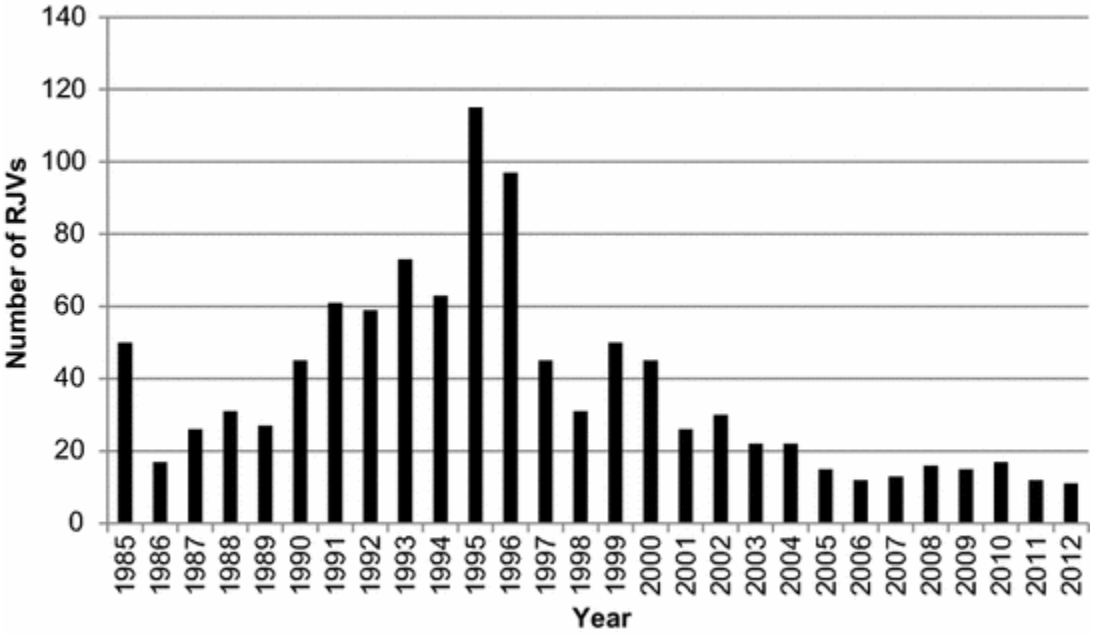

Fig. 1. Number of research joint venture filings in the *Federal Register*, by year (1985–2012)

Over time—especially during and shortly after the completion of a given RJV project—I have been able to interact with a number of individuals in the firms that formed the RJVs published in the *Federal Register*. This identification/contact/discussion process began in the late 1980s with the help of the leadership of the Program Office and the Advanced Technology Program (ATP) within the National Institute of Standards and Technology (NIST); these efforts were undertaken outside of NSF's support. My motivation for nurturing these contacts was to obtain data about

[7] See Hagedoorn et al. (2000) for a discussion of other databases on RJVs supported by NSF.
[8] The act stated: "In any action under the antitrust laws … the conduct of any person in making or performing a contract to carry out a joint research and development venture [i.e., an RJV] shall not be deemed illegal per se; such conduct shall be judged on the basis of its reasonableness, taking into account all relevant factors affecting competition, including, but not limited to, effects on competition in properly defined, relevant research and development markets." And, should a rule of reason test fail, damages would be actual and not treble.
[9] The National Science Board (2002, Chap. 4) drew explicitly on the CORE database in its discussion of US research alliances.
[10] The 1984 act was amended by the National Cooperative Research and Production Act (NCRPA) of 1993 (Public Law 103–42) and by the Standards Development Organization Advancement Act (SDOAA) of 2004 (Public Law 108–237). *Federal Register* filings under SDOAA are not included in Fig. 1.

the formation of each RJV and to track its progress over time in an effort to understand better its life cycle and related dimensions of its success/failure.[11]

Of the 1046 *Federal Register* filings through 2012, I have collected longitudinal project information on 117 RJVs.[12] This decade-long data collection process was not designed to be random. Rather, I made an effort to identify the founder for all RJVs, but contact information was not always available and even once identified, their willingness to participate in the data collection process waned over time.[13] Still, and by chance, the resulting sample of 117 RJVs, which I call the National Research Joint Venture Database (NRJVD), is balanced across years in terms of the membership size of each RJV at the time it was published in the *Federal Register*.[14]

Relevant to the theme of this section of the paper are the data in Table 1.[15] The research focus of an RJV is toward the research end of the R&D spectrum (Leyden and Link 2015). As a result, it should not be surprising to see that just over 50 % of the 117 RJVs that are represented in the NRJVD were formed to pursue an idea that primarily came from the in-house R&D of the founding firm (and less than 10 % came from non-research-based sources). Second, among the sources for the idea to form the RJV are ideas based on research information reported/discussed at scientific conferences. These finding may seem contradictory because the activities and findings from in-house R&D are confidential, yet findings presented at scientific conferences are immediately in the public domain; yet, both are based more on tacit knowledge than on codified knowledge (e.g., scientific publications).

Table 1. Most important information source for the formation of a US research joint venture

Information source	Most important source[a] (%)
New idea that resulted from our in-house R&D	53.7
Previously in-house idea that was pursued but did not succeed	3.7
Idea that resulted from knowing what our competitors were doing	7.1
Idea that resulted from customer feedback	2.0
Idea that resulted from research reported in scientific publications	6.5
Idea that resulted from research reported at scientific conferences	16.4
Idea that came from a firm member of the RJV	10.8
Idea that came from a university member of the RJV	<1.0

[a]Sum does not add to 100 % due to rounding

[11] I am grateful to my long-time friend and frequent mentor, Edwin Mansfield, for discussions about how to identify key individuals in an RJV and the type of information that might reasonably be collected over time. See Link and Scherer (2005). Clearly, the NRJVD (discussed below) was constituted in a Mansfield-like manner.

[12] These were filings under the NCRA of 1984 and under its amendment the National Research and Production Act (NCRPA) of 1993.

[13] As an example of the difficulties, one might encounter while trying to identify contact individuals in a RJV on the basis of only *Federal Register* information, see Link and Vonortas (2000).

[14] I am using the word *National* because the only systematic information on RJVs in the USA comes from *Federal Register* filings. OECD showed though purposive omission in *OECD Science, Technology and Industry Scoreboard 2013* (p. 125–126) that the USA is the only major OECD country for which there are no official data on firms collaborating on innovation—a proxy for RJV-like activity.

[15] OECD also showed though omission in *OECD Science, Technology and Industry Scoreboard* (2013, p. 124) that the USA is the only major OECD country for which there are no official data on firms' sources of knowledge for innovation.

More to the point and in particular to technology-based entrepreneurship and innovation is the question: Why is the primary source for the research being pursed in the RJV in-house R&D? Before I offer an answer to this question please keep in mind the stylized directional correlations in Table 2.

Table 2. Directional correlations from the national research joint venture database

The probability that the most important source for the formation of a US research joint venture is in-house R&D is positively correlated with:
the membership size of the RJV
the presence of non-US members in the RJV
a licensable output from the RJV

Why is the primary source for the research being pursued in the RJV in-house R&D? Cohen and Levinthal (1989, p. 569) have argued theoretically and demonstrated analytically that a firm's ability "to identify, assimilate, and exploit knowledge from the environment" depends on its own R&D effort.[16] Thus, a firm is more likely to form an RJV if it is in a position to capture or absorb the knowledge generated from the research interactions of the RJV members. A founding firm might be in such a position if it has a comparative advantage in the research being done, that is if the primary source of information for the formation of the RJV and its research agenda is based on the firm's in-house R&D.

Here is the take-away point from my discussion so far. Simply because the genesis of the idea for the formation of an RJV—or for that matter the formation of any R&D project—is generated internally within the firm, for that idea to reach internal fruition it must be noticed and acted on, otherwise that knowledge might spillover from the firm and result in a new venture creation (Acs et al. 2009). To make reference to Kirzner (1985, pp. 63–64), entrepreneurship should be viewed as a dynamic process:

> entrepreneurial alertness must include the entrepreneur's perception of the way in which creative and imaginative action may vitally shape the kind of transactions that will be entered into in future market periods.

And, as Schultz and Machlup (and Locke and Hume as well) would contend, such perception of the idea that should be pursued is based on the experiences of the firm.[17]

Concluding remarks

One might reasonably ask herself or himself: Why do I, as a scholar of entrepreneurship, innovation, and enterprise dynamics need to know about the sources of ideas that lead to a new technology or innovation? Well, perhaps no one does unless, as a researcher or even policy adviser, one is interested in identifying covariates with successful R&D-based activities.

[16] See also Cohen and Levinthal (1990).

[17] To liberally interpret the selected literature in organizational theory, and such perceptiveness might be part of the culture of the firm (Stinchcombe 1965; Baron et al. 1999).

As my review of selected research and my initial peak at the NRJVD data suggest, the source of the idea, or more broadly the source of the initial knowledge that motivated a particular R&D-based undertaking is directionally correlated with the success of that endeavor. While Table 2 is an inaugural look at the NRJVD—and certainly a more in-depth look will occupy my research agenda for some time to some—it does suggest that one output from an RJV is a licensable product or process and that has, at least among US RJVs, occurred more often when the motivating idea for the RJV's project came from the in-house R&D of the firm that formed the RJV.

From an operational perspective, consider a simple single-equation model of the performance of an R&D-based organization:

$$Performance = \mathrm{f}(\$R\&D, \mathbf{X}) \tag{1}$$

where *Performance* is either an index of R&D output over time or across firms that quantifies such behavior as the development of a new technology, bringing that technology to market, patenting the innovation, licensing the innovation, and so forth; *$R&D* measures the R&D expenditures in the organization, and **X** is a vector of firm or project characteristics. It would likely not surprise anyone here to learn that the regression coefficient on *$R&D* in this illustrative model is positive. But, and this is my punch line, such an econometric finding is not the whole story. Perhaps, what one should be thinking about in addition to the correlation between the level of R&D expenditures and related performance is the genesis of the idea for the R&D project itself.

If I may, let me proffer that if one controlled for the source of the idea for the R&D project in an extension of a cross-sectional version of the model in Eq. (1), one would find, holding the level of R&D expenditures constant, that those R&D organizations for which the idea for the R&D project came from internal sources would outperform those R&D organizations for which the idea came from other sources. And, of course, those organizations for which the idea for the R&D project emanated internally might be precisely those whose experience base is the richest and for which there is someone who recognizes the potential of the idea.

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