Universities as Research Partners:
Entrepreneurial Explorations and Exploitations

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I. Introduction
According to Schumpeter (1934), innovation can be described in several ways. Schumpeter spelled out initially a number of new combinations of resources and structures, including: 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, the capture of a new source of supply, and/or the new organization of industry. Overtime the forces of these new combinations dissipate as new becomes part of old. This is the dynamic character of innovation, but as such it does not change the essence of the entrepreneurial function. “Everyone is an entrepreneur only when he actually ‘carries out new combinations’” (Schumpeter 1934, p. 78), and he loses that character when his actions become old, or revert to the status quo.

Schumpeter also defined innovation by means of the production function. The production function “describes the way in which quantity of product varies if quantities of factors vary. If instead of quantities of factors, we vary the form of the function, we have an innovation” (1939, p. 62).

Schumpeter recognized that the knowledge supporting the innovation need not be new, although the combination of resources must. It may be that existing knowledge is used that has not been used before. He wrote (1928, p. 378):

[T]here has never been any time when the store of scientific knowledge has yielded all it could in the way of industrial improvement, and, on the other hand, it is not the knowledge that matters, but the successful solution of the task sui generis of putting an untried method into practice—there may be, and often is, no scientific novelty involved at all, and even if it be involved, this does not make any difference to the nature of the process.
Successful innovation requires an act of will, not intellect, he argued; successful innovation depends on leadership, not intelligence.

When firms initiate a research partnership with a university, or when a university initiates a research partnership with a firm, each is acting entrepreneurially as it systematically and purposely attempts to identify (i.e., explore) and capture a new source of supply—knowledge. Each then uses (i.e., exploits) systematically and purposely this new source of supply to create, among other things, a new method of production, be it a good or service or intellectual output. That new method of production can lead to a new market or organization of industry.¹

The goal of this essay is to broaden the scope of interpretation about universities as research partners. As our overview of selected, yet representative, elements of the extant literature on universities as research partners shows, most scholars who have approached this important topic have done so in what we call a structure-conduct-performance paradigm, defined in Section II (and we emphasize that we are loosely borrow that term from Mason (1939) and Bain (1949)). We argue that the literature should alternatively, and more broadly, be viewed within the intellectual thought of entrepreneurial activity as related to the creation and use of knowledge, or to innovation. As such, this literature has public policy implications, as discussed in Section III.

II. A Paradigmatic Overview of the Literature

Industry/university relationships have been strengthening in industrialized nations for decades. The Council on Competitiveness (1996, pp. 3-4) recently noted and emphasized this trend in the United States:

> [P]articipants in the U.S. R&D enterprise will have to continue experimenting with different types of partnerships to respond to the economic constraints, competitive pressures and technological demands that are forcing adjustments across the board. … [and in response] industry is increasingly relying on partnerships with universities …

¹ Bercovitz and Feldman (2007), building on the conceptual advances of Pisano (1991) and Chesbrough (2003), talk about exploration and exploitation in the context of upstream university research alliances.
A number of studies support this trend. For example, Link (1996) showed that university participation in formal research joint ventures (RJVs) has increased steadily since the mid-1980s, Cohen, Florida, Randazzese, and Walsh (1997) documented that the number of industry/university R&D centers increased by more than 60 percent during the 1980s, and a recent survey of U.S. science faculty by Morgan (1998) revealed that many desire even more partnership relationships with industry. Mowery and Teece (1996, p. 111) contend that such growth in strategic alliances in R&D is indicative of a “broad restructuring of the U.S. national R&D system.”

According to Hall, Link, and Scott (2000, 2003) little is known about the types of roles that universities play in such research partnerships or about the economic consequences associated with those roles. What research there is on the topic of universities as research partners falls broadly into either examinations of industry motivations or of university motivations for engaging in an industry/university research relationship.

As Hall, Link, and Scott (2000, 2003) note, the literature has identified two broad industry motivations for engaging in an industry/university research relationship. The first is access to complementary research activity and research results. Rosenberg and Nelson (1994, p. 340) emphasized:

> What university research most often does today is to stimulate and enhance the power of R&D done in industry, as contrasted with providing a substitute for it.

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2 Hall’s (2004) subsequent emphasis on industry/university research partnerships in the United States is on intellectual property. See also the role of intellectual property protection mechanisms (Hertzfeld, Link, and Vonortas 2006).

3 Cohen, Florida, Randazzese, and Walsh (1997) provide a selective review of this literature, emphasizing the studies that have documented that university research enhances firms’ sales, R&D productivity, and patenting activity. See, Blumenthal, Gluck, Lewis, Stoto, and Wise (1986); Jaffe (1989); Adams (1990); Berman (1990); Feller (1990); Mansfield (1991, 1992); Van de Ven (1993); Bonaccorsi and Piccaluga (1994); Klevorick, Levin, Nelson, and Winter (1994); Zucker, Darby, and Armstrong (1994); Henderson, Jaffe, and Trajtenberg (1995); Mansfield and Lee (1996); Zeckhauser (1996); Campbell (1997); and Baldwin and Link (1998). Cockburn and Henderson (1997) show that it was important for innovative pharmaceutical firms to maintain ties to universities. Hall, Link, and Scott (2000, 2003) suggest that perhaps such research ties with universities increase the “absorptive capacity,” in the sense of Cohen and Leventhal (1990), of the innovative firms.
Pavitt (1998), based on his review of this literature, was more specific in this regard. He concluded that academic research augments the capacity of businesses to solve complex problems. The second industry motivation is access to key university personnel.4

*University motivations* for partnering with industry seem to be financially based. Administration-based financial pressures for faculty to engage in applied commercial research with industry are growing.5 Zeckhauser (1996, p. 12746), for example, was subtle when he referred to the supposed importance of industry-supported research to universities as he describes how such relationships might develop:

> Information gifts [to industry] may be a part of [a university’s] commercial courtship ritual.

Along those same lines, Cohen, Florida, Randazzese, and Walsh (1997, p. 177) argued that:6

> University administrators appear to be interested chiefly in the revenue generated by relationships with industry.

They are also of the opinion that faculty, who are fundamental to making such relationships work:

> … desire support, *per se*, because it contributes to their personal incomes [and] eminence … primarily through foundation research that provides the building blocks for other research and therefore tends to be widely cited.

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4 See Leyden and Link (1992) and Burnham (1997). Link (1995) documented that one reason for the growth of Research Triangle Park (North Carolina) was the desire of industrial research firms to locate near the triangle universities (University of North Carolina in Chapel Hill, North Carolina State University in Raleigh, and Duke University in Durham).

5 See Berman (1990), Feller (1990), and Henderson, Jaffé, and Trajtenberg (1995), and Siegel, Waldman, and Link (1999).

6 Siegel, Waldman, and Link (1999) document that university administrators consider licensing and royalty revenues from industry as an important output from university technology transfer offices.
However, several drawbacks to university involvement with industry have been identified, such as the diversion of faculty time and effort from teaching, the conflict between industrial trade secrecy and traditional academic openness, and the distorting effect of industry funding on the university budget allocation process (in particular, the tension induced when the distribution of resources is vastly unequal across departments and schools).

Table 1 summarizes selected, yet representative, recent empirical research related to universities as research partners. Defining “conduct” as partnering with a university and “structure” as those firm or university or environmental characteristics that bring about partnering, then the structure → conduct literature can be summarized as follows.

To generalize, observing universities partnering with firms—conduct—is more likely in the following independent situations—structure:

- the firm is engaged in exploratory internal R&D (Bercovitz and Feldman 2007)
- the firm is mature and large (Stuart, Ozdemir, and Ding 2007; Fontana, Geuna, and Matt 2006)
- there is a lack of intellectual property issues between the firm and the university (Hall 2004; Hall, Link, and Scott 2001)
- university faculty are male, with tenure, and are part of a university research center (Boardman and Corley 2008; Link, Siegel, and Bozeman 2007)

Table 2 focuses on conduct-performance where “performance” is defined in terms of the economic consequences of partnering with a university. The conduct → performance literature can be summarized as follows:

Given a university/industry research partnership—structure, it is likely that the following attributes—performance—will be observed:
• there will be two-way flows of knowledge through publication and conferences, and through the formation of research joint ventures (Cohen, Nelson, and Walsh 2002; Link 2005; Link and Scott 2005; Hertzfeld, Link, and Vonortas 2006)
• firm R&D will be more successful (Link and Rees 1990; Hall, Link, and Scott 2000, 2003, Kodama 2008)
• university research parks will grow as will attendant industries (Link and Scott 2007; Bozeman, Hardin, and Link 2008)

III. Discussion
As we stated in the Introduction to this essay, it is our position that the literature on universities as research partners should be viewed within the intellectual thought of entrepreneurial activity as related to the creation and use of knowledge, or to innovation. And, we contend, that it is this nexus between entrepreneurial activity and innovation that implies that this subject has public policy implications.7 We discuss these implications specifically in light of one important U.S. program, the Small Business Innovation Research (SBIR) program.

The SBIR program is a public/private partnership that funds private R&D with grants both as a means of meeting government mission and of complementing the results of federal research.8 A prototype of the SBIR program began at the National Science Foundation in 1977 (Tibbetts 1999). At that time, the goal of the program was to encourage small businesses, increasingly recognized to be a source of innovation and employment in the U.S. economy, to participate in NSF-sponsored research, especially research that had commercial potential. Because of the early success of the program at NSF, Congress passed the Small Business Innovation Development Act of 1982 (P.L. 97-219; hereafter, the 1982 Act).9

7 Link and Link (2009) emphasize this point and illustrate its importance using several examples of U.S. public/private partnerships. They argue that viewing government as entrepreneur is a unique lens through which a specific subset of government policy actions can be characterized. This perspective underscores the purposeful intent of government, its ability to act in new and innovative ways, and its willingness to undertake policy actions that have uncertain outcomes.


9 Total factor productivity growth, a measure of technological advancement, slowed in the United States, and in most industrial nations, in the early 1970s and then again in the late 1970s. The latter slowdown extended to the early 1980s. In response, a number of technology-based policies were initiated including the 1980 R&E Tax Credit
The 1982 Act required all government departments and agencies with external research programs of greater than $100 billion to establish their own SBIR programs and to set aside funds equal to 0.20 percent of the external research budget. In 1983, this amount totaled $45 million.

The 1982 Act stated that the objectives of the program are:

1. to stimulate technological innovation
2. to use small business to meet Federal research and development needs
3. to foster and encourage participation by minority and disadvantaged persons in technological innovation
4. to increase private sector commercialization of innovations derived from federal research and development.

As part of the 1982 Act, SBIR’s awards are structured as defined by three phases. Phase I awards are small, generally less than $100,000 for the six month award period. The purpose of Phase I awards is to assist firms as they assess the feasibility of an idea’s scientific and commercial potential in response to the agency’s objectives. Phase II awards typically range up to $750,000 over two years. These awards are for the firm to develop further its proposed research, ideally leading to a commercializable product, process, or service. The Phase II awards of public funds for development are sometimes augmented by private funding from outside the firm. Further work on the projects launched as SBIR projects occurs in what is called Phase III, and Phase III does not involve SBIR funds. It is the stage when the firm, if it needs additional outside finance, should obtain outside funding from sources other than the SBIR program to ensure that the product, process, or service can move into the marketplace.

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and the National Cooperative Research Act of 1984. The 1982 Act is one such initiative, although public support for enhancing innovation in small firms can be traced to as early as the 1960s (Turner and Brown 1999).

10 SBIR is a set aside program; it redirects existing R&D funds for competitive awards to small business rather than appropriating new monies for R&D for small firms

11 As stated in the 1982 Act, to be eligible for an SBIR award, the small businesses must be: independently owned and operated; other than the dominant firms in the field in which they are proposing to carry out SBIR projects; organized and operated for profit; the employer of 500 or fewer employees, including employees of subsidiaries and affiliates; the primary source of employment for the project’s principal investigator at the time of award and during the period when the research is conducted; and at least 51 percent owned by U.S. citizens or lawfully admitted permanent resident aliens.
In 1992, the SBIR program was reauthorized until 2000 through the Small Business Research and Development Enactment Act (P.L. 102-564). Under the 1982 Act, the set aside had increased to 1.25 percent; the reauthorization increased that amount over time to 2.50 percent and re-emphasized the commercialization intent of SBIR-funded technologies (see point (4) of the 1982 Act above).12 The Small Business Reauthorization Act of 2000 (P.L. 106-554) extended the SBIR program until 2008, and it kept the 2.50 percent set aside amount.13

Eleven agencies currently participate in the SBIR program: the Environmental Protection Agency (EPA), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), and the Departments of Agriculture (USDA), Commerce (DoC), Defense (DoD), Education (ED), Energy (DoE), Health and Human Services (HHS), Transportation (DoT), and, most recently, Homeland Security (DHS). DoD maintains the largest program; DoD, HHS, NASA, DoE, and NSF—have accounted over time for nearly 97 percent of the program expenditures.

According to Wessner (2008), universities are prominently involved in linking SBIR recipient firms to the marketplace. In a recent balanced survey of Phase II award recipients, conducted by the National Research Council, about one-third of all survey respondents indicated that there had been involvement by university faculty, graduate students, and/or a university itself in the development of technologies from SBIR-funded research. And in addition, more than two-third of funded Phase II projects were in firms with at least one academic founder, in nearly one-third of funded Phase II projects a university faculty was the principal investigator or consultant, and in nearly one-fifth of the projects universities served as subcontractors. See Table 3. Relying on these same data, Link and Ruhm (2008) demonstrated that, among NIH-funded Phase II projects, those projects with university involvement enjoyed a greater probability of commercialization of the technology from the project.14

Table 3 about here

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12 The percentage increased to 1.5 in 1993 and 1994, and then to 2.0 in 1995 and 1996, and then to 2.5 in 1997.  
13 At the time of writing this essay, reauthorization is still being debated in the U.S. Congress.  
14 This finding is not inconsistent with Link and Rees (1990); see Table 2.
Regarding the policy implications that flow from our paradigmatic overview of the literature, albeit selective yet representative, publicly-funded research projects could be selected at the margin, holding the quality of the proposed research constant, on the basis of whether or not the funded firm will include university talent as a research resource. Building on the arguments proffered by Leyden and Link (1999) and Link and Scott (2005), the university could act as an honest broker providing insights into the research while at the same time preserving appropriability.

Hall, Link, and Scott (2003) argued, on the basis of publicly-funded research through the Advanced Technology Program (ATP) within the National Institute of Standards and Technology (NIST), that universities create research awareness thus facilitating sooner than expected completion of research projects. The inclusion of universities as research partners may be most effective when the research involves “new” science (Hall, Link, and Scott 2003, p. 491):

Industrial research participants perceive that the university could provide research insight that is anticipatory of future research problems and could be an ombudsman anticipating and communicating to all parties the complexity of the research being undertaken.

Thus, well known as a engine of economic growth, incentives to firms and universities to include universities as an industrial research partner could be an important policy innovation and one that is based on the view that the dual search for such knowledge is in itself an entrepreneurial endeavor.
Table 1
Selected Literature on Universities as Research Partners: Structure → Conduct

<table>
<thead>
<tr>
<th>Author(s) (alphabetically)</th>
<th>Observations</th>
<th>Findings</th>
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</thead>
<tbody>
<tr>
<td>Bercovitz, Feldman (2007)</td>
<td>Canadian R&amp;D firms</td>
<td>Firms more likely to establish university research relationships when internal R&amp;D is exploratory</td>
</tr>
<tr>
<td>Boardman, Corley (2008)</td>
<td>U.S. university faculty survey data</td>
<td>Likelihood of industry-university research collaboration greater when university scientists are affiliated with an industry-liked university research center</td>
</tr>
<tr>
<td>Fontana, Geuna, Matt (2006)</td>
<td>KNOW survey of EU firms</td>
<td>Larger firms more likely to collaborate with public research organizations (i.e., universities)</td>
</tr>
<tr>
<td>Hall (2004)</td>
<td>Literature review</td>
<td>IP mechanisms effect the extent and scope of industry-university research relationships</td>
</tr>
<tr>
<td>Hall, Link, Scott (2001)</td>
<td>Research projects funded by U.S. Advanced Technology Program (ATP)</td>
<td>When research results are expected to be less appropriable, IP issues prevent the industry/university partnership from taking place</td>
</tr>
<tr>
<td>Link, Siegel, Bozeman (2007)</td>
<td>U.S. university faculty survey data</td>
<td>Male tenured faculty are more likely to engage in informal research relationships with industry</td>
</tr>
<tr>
<td>Stuart, Ozdemir, Ding (2007)</td>
<td>U.S. biotechnology firms</td>
<td>Biotechnology firms upstream alliances with universities increase as firms mature</td>
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Source: Compiled by the authors.
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<tr>
<td>Bozeman, Hardin, Link (2008)</td>
<td>North Carolina nanotechnology firms</td>
<td>Lack of access to university faculty is a significant barrier to the growth of nanotechnology firms.</td>
</tr>
<tr>
<td>Cohen, Nelson, Walsh (2002)</td>
<td>Carnegie Mellon survey of industry R&amp;D firms</td>
<td>Key channels through which university research impacts industry R&amp;D are indirect, including publications, conferences and information relationships.</td>
</tr>
<tr>
<td>Hall, Link, Scott (2000, 2003)</td>
<td>Research projects funded by U.S. Advanced Technology Program (ATP)</td>
<td>Projects with universities as research partners are in areas involving “new” science and are thus experience more difficultly and delay; universities contribute to basic research awareness and thus help to ensure the project’s successful completion</td>
</tr>
<tr>
<td>Hertzfeld, Link, Vonortas (2006)</td>
<td>U.S. firms involved in research joint ventures</td>
<td>Industry learns through prior partnership experiences with universities how to overcome IP problems</td>
</tr>
<tr>
<td>Kodama (2008)</td>
<td>Research firms in TAMA cluster region of Japan</td>
<td>No relationship between university research collaboration and firm size of firm profitability</td>
</tr>
<tr>
<td>Link (2005)</td>
<td>U.S. research joint ventures</td>
<td>Upward trend in the percent of RJVs with U.S. university as a research member</td>
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<tr>
<td>Link, Rees (1990)</td>
<td>Interview data form U.S. research firms</td>
<td>Productivity of R&amp;D increases with a university is involved, especially in smaller firms</td>
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<tr>
<td>Link, Ruhm (2008)</td>
<td>U.S. Small Business Innovation Research (SBIR) program projects funded by National Institutes of Health (NIH)</td>
<td>Probability of commercialization greater in those projects with university involvement in the research</td>
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<td>Link, Scott (2005)</td>
<td>U.S. research joint ventures</td>
<td>Larger RJVs more likely to include university as research partner</td>
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<tr>
<td>Link, Scott (2007)</td>
<td>Literature review on university research parks</td>
<td>Growth of university research parks, which is one indicator of intent of universities to partner with industry in research, is a post-WWII and it continued into the 1980s and then has been sporadic but positive</td>
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Source: Compiled by the authors.
<table>
<thead>
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<th>Percentage</th>
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<tr>
<td>2%</td>
<td>of projects had a university faculty member as the principal investigator</td>
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<tr>
<td>3%</td>
<td>of projects had an adjunct faculty member as the principal investigator</td>
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<tr>
<td>22%</td>
<td>of projects had a faculty or adjunct faculty member as a consultant</td>
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<tr>
<td>15%</td>
<td>of the projects involved graduate students</td>
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<tr>
<td>13%</td>
<td>of the projects relied on university facilities or equipment</td>
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<tr>
<td>3%</td>
<td>of the projects relied on technology licensed from a university</td>
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<tr>
<td>5%</td>
<td>of the project relied on technology developed at a university by one of the participants in the project</td>
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<tr>
<td>17%</td>
<td>of the projects had a university as a subcontractor</td>
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References


