The Relative Importance of Firms, Universities, Governments, and Nonprofits as Innovation Intermediaries

ABSTRACT

Using survey data from a sample of 499 firms from four countries, we conduct a comparative examination of the nature and importance of the innovation enabling contributions of firms, universities, governments, industry associations, and research institutes.

Governments everywhere invest heavily in dedicated innovation intermediaries, government programs and nonprofit organizations whose purpose is to facilitate innovation in order to increase the prospects for firm founding, growth, profitability, and survival. But it is not clear that these investments are yielding the hoped for socio-economic returns. While some researchers have found evidence of a positive impact (Debackere & Veugelers, 2005; Grindley, Mowery, & Silverman, 1994; Human & Provan, 1997; Lee, Yoon, & Park, 2009; Sakakibara & Branstetter, 2003; Sapsed, Grantham, & DeFillippi, 2007), others have found no impact or even negative impact (Baum, Calabrese & Silverman, 2000; King & Lenox, 2000; Shearmur & Doloreux, 2000; Wallsten, 2000). With strong evidence of the important role that for-profit firms play in facilitating innovation amongst other firms in their ecosystem (Chesbrough, 2003; Dyer & Hatch, 2006), some observers may believe that social welfare would benefit from reduced support for government-subsidized, dedicated innovation intermediaries.

In the interests of a better understanding of the relative contributions of a range of organizational actors whose activities may, either intentionally or unintentionally, have an innovation facilitating effect on the firms with which they engage, we conduct a comparative examination of the relative importance of firms, universities, governments, industry associations, and research institutes as innovation intermediaries.

This small but highly heterogeneous group of organizational actors engages in a wide range of activities for a wide range of different purposes. So to make our study tractable, we abstract from the vast differences in the purposes, resources, and activities of these organizational actors, and in the nature of engagements between these actors and sample firms, to consider only the outcomes of innovation facilitating activities. In this exploratory study, we consider ten innovation intermediation outcomes that include those related to learning, the facilitation of collaboration, and those that are a consequence of changing regulations or social pressure.

Our study builds on the contributions of the literature on innovation intermediaries and the studies that have used Community Innovation Survey (CIS) data. The literature on innovation intermediaries provides rich descriptions of activities and reports on the impact of specific types of intermediaries. University-based technology transfer offices help firms to learn new technologies (Debackere & Veugelers, 2005); business clinics (Sapsed et al., 2007) and consultants (Hargadon & Sutton, 1997) provide access to business-related information and advice; industry associations and innovation networks enable access to opportunities for networking and knowledge sharing (Dalziel, 2006; Human & Provan, 1997); and research consortia facilitate collaboration (Grindley et al., 1994; Sakakibara & Branstetter, 2003). But to date there has been no attempt to conduct a comparative analysis of the impact of a range of innovation intermediaries. We have knowledge of the impact of innovation intermediaries such as SEMATCH (Grindley et. al., 1994), the Small Business Innovation Research Program (Lerner, 1999), and Swedish science parks (Löfsten & Lindelöf, 2002), but we know nothing of their relative magnitude of their contributions.

CIS data benefit from large random samples and provide insights into various aspects of the innovation process (OECD, 2005). But CIS surveys conflate a wide range of activities into a single definition of innovation (Tether, 2001), lack a set of indicators that reflect specific innovation activities or processes (Arundel, 2007), and provide limited information on how innovation linkages and networks function and

develop (Salazar & Holbrook, 2004). The most relevant limitation for the present purposes is that only two innovation intermediation processes are considered: Sources of information and the nature of cooperation partners. Furthermore, the possible responses to sources of information and cooperation partners questions are not limited to actors but also include roles (e.g. customer, supplier), venues (e.g. conferences, trade shows), and artifacts (e.g. patents, embodied technology) (OECD Oslo Manual, 2005: p81). This makes it impossible to compare the importance of various organizational actors unless it is assumed, as is often the case, that roles such as customer and supplier are always performed by for-profit firms (Amara & Landry, 2005; Freel, 2000; Laursen & Salter, 2006; Segarra & Arauzo, 2008; Veugelers & Cassiman, 2005). As a consequence of this assumption, the literature may overestimate the impact of for-profit firms as information sources and cooperation partners, and underestimate the impact of governments, universities, and nonprofit organizations that may also act as customers and suppliers.

Our contribution is, we believe, the first comparison of the relative importance of a range of organizational actors as innovation intermediaries. We draw on a sample of 499 firms from four countries to consider the relative importance of ten innovation intermediation outcomes and the degree to which firms, universities, governments, industry associations, and research institutes, are associated with each of these outcomes. We find that enabling outcomes are judged to be more important than outcomes that arise as consequence of coercive regulations or social pressure, and that learning outcomes are judged to be more important than the facilitation of collaboration outcomes. We find that firms are identified as the most important business facilitators, universities as the most important technical facilitators, governments as the most important coercive actors, and industry associations as the most important facilitators of collaboration. We also consider regional and sectoral variations.

In the next section we draw on the literature on innovation intermediation to identify ten innovation intermediation outcomes that may be the result of interventions by a range of organizational actors. We then develop hypotheses regarding the outcomes that are most likely associated with, respectively, the

interventions of firms, universities, governments, and industry associations. In the methods section we present our sample and measures, and in the results section we report on the outcomes of our regression analysis. We conclude with a discussion of our findings and their implications.

CONCEPTUAL DEVELOPMENT

Innovation Intermediation Outcomes

While researchers have documented the activities of dedicated innovation intermediaries, and the effects of these activities on firms, the activities of other organizational actors such as firms, universities, and governments may also have an effect on the resources and capabilities of firms and thereby on firm founding, growth, profitability, or survival. While possible effects or outcomes are infinite in number and variety, in this exploratory study we focus on just ten possible effects that are selected on the basis of their importance, and their intangible and social nature. Many organizations provide firms with access to tangible resources: Equity investors and governments may provide access to financing, alliance and outsourcing partners may provide access to manufacturing services, and business incubators and science parks may provide physical space on advantageous terms. But as the origin of tangible resources is more easily traced, much is known about their provenance. For this reason we focus on innovation intermediation outcomes related to learning and the facilitation of collaboration, social processes whose initial outcomes are intangible. We also consider innovation intermediation outcomes that are not the result of enabling processes but that are the outcome of coercive processes intended to balance the interests of firms with the interests of other stakeholders and the environment.

We build on the two innovation intermediation process questions included in CIS surveys: sources of information and collaboration partners. In the first instance, we build on the sources of information question by considering the means by which firms learn about technology, markets, and their sources for

business information and advice. Studies in the innovation literature have emphasized the importance of learning about both technologies and markets (Kline & Rosenberg, 1986; Dougherty, 1990) and the literature on small firm innovation has identified the important role of business advice in enhancing the growth of small firms (Bennett & Robson, 1999). Firms transfer new technologies through licensing to subsidiaries in foreign countries and thereby promote inter-firm technological learning (Wakasugi & Ito, 2009) and university researchers, sometimes through their institutional technology transfer office, assist in the resolution of technological problems (Debackere & Veugelers, 2005; Muscio, 2010). Alliances with partner firms may facilitate downstream marketing and the distribution of products (Li & Atuahene-Gima, 2002), industry associations facilitate learning about markets by hosting trade shows (Dalziel, 2006), governments may facilitate learning about emerging markets (Svensson, 2007). Specialized intermediaries, such as accountants, consultants, solicitors, and banks, facilitate access to business advice (Bennett & Robson, 1999; Gooderham et al., 2004), as do bridging organizations such as Wired Sussex in the UK through mentoring activities (Sapsed et al., 2007).

We build on the collaboration partners question by considering two aspects of the facilitation of collaboration: the identification of partners for collaboration and the building or strengthening of ties between partners. We distinguish between two types of partners: knowledgeable individuals, and organizational partners such as firms. Many innovation intermediaries, such as university technology transfer offices, identify knowledgeable individuals that may serve as collaboration partners (Gregorio & Shane, 2003; Grossman, Morgan, & Reid, 2001; Perkmann & Walsh, 2008; Sorensen & Chambers, 2008). The identification of partner firms and organizations similarly plays an important role in the initial stages of building collaborative relationships, and participation in standards committees allow firms, especially those with fewer alliances, to identify suitable alliance partners (Rosenkopf, et al., 2001).

We consider three ways in which ties between collaborating partners may be built or strengthened: the facilitation of collaboration, the promotion of enabling standards, and the undertaking of innovative

activities on behalf of firms. Networks facilitate inter-organizational exchanges amongst small- and medium-sized firms (Human & Provan, 1997), and US government programs facilitate collaboration by offering financial support (Lerner, 1999; Sakakibara & Branstetter, 2003). The Cambridge-MIT Institute is an example of a program that supports university-industry collaboration and knowledge sharing (Acworth, 2008). Industry associations help small and medium firms build cooperative ties and compensate for limited trust between network members (Lee, et al., 2009). Inter-firm cooperation that is publicly funded is more stable than privately funded cooperation in the short run, but less successful in the long run (Matt & Wolff, 2004).

The development of enabling standards facilitates innovation (Shapiro & Varian, 1998), and SEMATECH is an example of an intermediary that promotes common enabling standards for collaboration between supplier firms and user firms (Grindley et al., 1994). Government funded technology program Smart and Modular Building Automation (SaMBA) facilitates an open interfere standard and hence assists SMEs in the commercialization of their innovative products (Hyvattinen, 2006). Finally, some organizations have the trust and expertise required to undertake innovative activities on behalf of firms. SEMATECH improves and qualifies products on behalf of its member firms (Grindley et al., 1994), and the US National Institute of Standards and Technology conducts research to help the semiconductor industry produce and improve innovative devices (Rowe & Temple, 2011). Federal laboratories also conduct basic research on behalf of firms (Rogers & Bozeman, 1997).

While the CIS survey considers only the effect of enabling processes, we also consider the outcomes of coercive processes that force firms to innovate by balancing the interests of the firms with the interests of other agents or the environment. Environmental regulations in some cases oblige firms to innovate (Porter & Linde, 1995). Firms are also influenced by implicit social norms. The firms in a Chemical Manufacturing Association have been imposed social pressure, but the findings show that member firms improve environment performance more slowly than non-member firms (King & Lenox, 2000). In

contrast, Canadian forestry products firms perceive that social pressure, such as environmental protests and lobbying, has a positive influence on eco-design sustainability decisions (Sharma & Henriques, 2005). Table 1 lists the ten innovation intermediation outcomes described above.

Table 1: Ten Innovation Intermediation Outcomes

Nature of Outcome	Specific Outcomes
Facilitation of Learning	1. Helps our firms learn about new technologies 2. Helps our firms learn about new markets 3. Provides our firm with business advice
Facilitation of Collaboration Identification of partners	4. Identifies knowledgeable individuals 5. Identifies partner firms and organizations
Building ties between partners	6. Facilitates collaboration 7. Promotes enabling standards 8. Undertakes innovation activities on behalf of firms
Coercive Outcomes	9. Forces us to innovate by changing regulations 10. Forces us to innovate through social pressure

Innovation Intermediary Actors

In the following we consider the likely impacts of firms, universities, governments, and industry associations on the innovative capacities of the firms with which they engage. While there is a reasonable consensus on the importance of firms, universities, and governments as innovation intermediaries, there is little systematic evidence of their relative importance. And while some authors have allowed for the importance of industry associations as enablers of innovation (Dalziel, 2006; Kennedy, 2008; Lee et al., 2009), others have discounted their innovation enabling capabilities, suggesting that their activities are limited to lobbying and promotion (Human & Provan, 1997). Taking each organizational actor in turn, we consider the types of innovation intermediation outcomes whose importance is most likely to be strongly associated with the importance of the actor in question as a facilitator of that outcome.

The importance of for-profit firms. In our era of open innovation, large firms at the centre of business ecosystems may have a significant impact on the resources and innovative capacities of the firms with which they engage (Chesbrough, 2003; Iansiti & Levien, 2003). Such firms may serve as lead customers (von Hippel, 1986), system integrators (Baldwin & Clark, 2000), or as platform leaders (Gawer & Cusumano, 2002), and in such roles they may facilitate the learning of firms that are their suppliers or complementors (Dyer & Hatch, 2006). Alliances are another means by which firms may learn from other firms (Sampson, 2007), and even without a sustained direct relationship large firms may have a significant impact on the firms in their region, as they may be a source of spinoffs, corporate venture capital, or knowledge spillovers (Klepper, 2007). Finally, professional service firms may also have a significant impact on the innovative capacities of firms. Such firms include management consultancies that offer business or technological advice (Bennett and Robson, 1999; Bessant & Rush, 1995), design consultancies such as IDEO (Hargadon & Sutton, 1997), or financial or human resources service firms (Zhang & Li, 2010).

But while membership in the networks of dedicated intermediaries is generally open to all firms and allows firms to maintain complete autonomy, membership in the networks of the sometime intermediaries such as for-profit firms may be limited to their suppliers or clients and may involve compromised autonomy for participating firms. This means that not only are such networks and alliances inaccessible or unsuitable for most firms, they may offer reduced network size, scope, and benefits for participating firms. In addition, firms may abandon their commitment to the facilitation of collaboration in favor of their private interests, as Sun Microsystems (Garud, Jain & Kumaraswamy, 2002) and Intel (Gawer & Cusumano, 2002) have reportedly done.

So, of the innovation intermediation outcomes described in the previous section, firms may be well positioned to facilitate learning, but will not be consistently motivated to do so. And they may not be

trusted to facilitate collaboration and may not have the authority or legitimacy required to oblige other firms to innovate through regulatory changes or social pressure. Where it is in their interest to share information, they will be much better placed than other actors to share information related to markets and business advice. Therefore we expect firms to be the actors most strongly associated with the facilitation of business-related learning and within this category to be associated with helping firms learn about new markets and with the provision of business advice.

Hypothesis 1: For-profit firms are more strongly associated with the facilitation of business-related learning than governments, universities, industry associations, or research institutes. Specifically, firms are the actors most strongly associated with the importance of the following processes:

- *Assistance with learning about new markets*
- *Provision of business advice*

The importance of universities. Universities are natural facilitators of the innovative activities of firms as universities are generally committed to learning and to the open dissemination of research results (Dasgupta & David, 1994). In particular, universities are a natural source of expertise, both through their role as a source of employees, including highly-qualified employees with advanced degrees, and through their role as a source of researchers for that may be engaged on a contract basis. Alliances with star researchers have been shown to have a significant positive impact on firm success (Zucker, Darby & Armstrong, 2002). Given the high potential of university-industry alliances, university technology transfers offices are now ubiquitous and university business incubators and science parks are common (Debackere & Veugelers, 2005; Rothaermel & Thursby, 2005; Siegel et al., 2003)

But the knowledge generation and education objectives of universities may limit their ability to engage in external partnerships (Salter & Martin, 2001). Even though researchers recognize that their findings are unlikely to be commercialized without further development and testing, they are reluctant to undertake

such activities because doing so will detract from their ability to produce measureable outputs such as high quality papers that are likely to be cited. As a consequence, university inventions, even those that are licensed, are embryonic in nature and require further development once they are licensed (Jensen & Thursby, 2001).

Like for-profit firms, universities are not dedicated innovation intermediaries. While universities, and university technology-transfer offices in particular, may promote university-industry engagement, university researchers face competing incentives and must balance their engagement with industry with other demands on their time. Where it is in their interest to share information and expertise with firms, they may be better placed than other actors to share technology-related information. Universities are also well-positioned to serve as a source of knowledge individuals and to undertake innovative activities on behalf of firms.

Hypothesis 2: Universities are more strongly associated with the facilitation of technology-related learning than for-profit firms, governments, industry associations, or research institutes. Specifically, universities are the actors most strongly associated with the following processes:

- *Assistance with learning about new technologies*
- *Identification of knowledgeable individuals*
- *Undertaking innovation activities on behalf of focal firms*

The importance of governments. Government agencies enable the innovation process by providing financial support and facilitating collaborations involving multiple organizations. An important example of the provision of direct financial support is the Small Business Innovation Research (SBIR) program of the US (Lerner, 1999), but governments may also offer indirect support through the provision of tax credits (Czarnitzki, Hanel, & Rosa, 2011). Governments can also be said to facilitate collaboration insofar as they sponsor research consortia (Aldrich & Sasaki, 1995; Feldman & Kelly, 2006; Sakakibara &

Branstetter, 2003). And in some instances governments may go beyond intermediation to provide innovation leadership. Fuchs (2010) describes the activities of DARPA (the US Defense Advanced Research Projects Agency) as going beyond network broking and engaging in leadership activities that as it "re-architects social networks among researchers so as to influence technology directions in the US".

But governments prefer to support median voter, not special interest groups (Weisbrod, 1991). As a consequence government efforts at stimulating innovation are generally, though not always, broad programs that appeal to firms in all industries and regions under their jurisdiction. The US SBIR program is a case in point. At the same time, governments play a unique role in establishing regulations that may have an innovation inducing effect. For example, well-designed environmental policies may lead to enhanced efficiency, efficient production technology (Porter & Linde, 1995), and the founding of firms that supply energy from renewable sources (Sine et al., 2002). In so doing, government agencies attempt to satisfy the interests of majorities by balancing the interests of focal firms and the interests of other constituents in society, such as the public welfare, social security, and the environment.

On balance we believe that governments will not be the most important actor associated with any enabling process. But they do play an important role in creating and maintaining institutional frameworks, which may or may not be enabling. Of the ten innovation intermediation outcomes that we consider we believe governments will be the most important actors associated with processes that oblige firms to innovate as a consequence of changes in regulations, or that oblige firms to innovate as a consequence of normative social pressures.

Hypothesis 3: Government agencies are more strongly associated with the importance of coercive processes than for-profit firms, universities, industry associations, or research institutes. Specifically, governments are the actors most strongly associated with the following processes:

- *Innovation necessitated by changing regulations*

- *Innovation necessitated by social pressure*

The importance of industry associations. While some researchers distinguish between organizations that facilitate innovation, and industry associations whose activities they regard as confined to lobbying and promotion (Human & Provan, 1997), other researchers have found that industry associations have a positive impact on the innovative capacities of the firms with which they engage. Murmann (2003) reports on the important role played by industry associations in the co-evolution of the capabilities of German industry and academe during the 19th and early 20th century. Dalziel (2006) reports that when Statistics Canada included industry associations as a source of ideas and as a potential collaboration partner on an innovation survey, respondents were significantly more likely to identity industry associations as responses than either universities or government research laboratories. Lee et al. (2009) describe a Korean industry association that allows member firms to identify partners and facilitate innovation collaborations, and participation in the standards committees of industry associations has been shown to influence the formation of alliances (Rosenkopf, Metiu, & George, 2001).

But the impact of industry associations on the innovative capacities of firms may not always be positive. Baum, Calabrese, and Silverman (2000) find a negative relationship between participation in industry associations and growth in revenues and R&D spending. They attribute this finding to the fact that founders without personal networks may be more likely to join industry associations to compensate for their lack of contacts. Similarly, King and Lenox (2000) examine the effect of participation in the Chemical Care program of the Chemical Manufacturing Association in the US and find that participating firms are less likely to reduce their toxic emissions than non-participating firms.

Every national economic system consists primarily of numerous small and medium enterprises (SMEs). As SMEs typically do not perform R&D, they may not avail themselves of the services of universities or research institutes. In some cases they may engage with few external actors and in such cases industry

associations may be important in helping them establish networks with other enterprises. Such firms may find industry associations reliable and trustworthy partners because of their geographic and cognitive proximity. On the basis of the foregoing we believe that industry associations will be the actors that are most strongly associated with the identification of partner firms and organizations, the facilitation of collaboration, and the promotion of enabling standards.

Hypothesis 4: Industry associations are more strongly associated with the importance of the facilitation of collaboration than for-profit firms, governments, universities, or research institutes. Specifically, industry associations are the actors most strongly associated with the following processes:

- *Identification of partner firms and organizations*
- *Facilitation of collaboration involving multiple organizations*
- *Promotion of enabling standards*

METHODOLOGY

Sample

We use data from an extensive international innovation survey conducted in 2005-2007. The survey was sent to the vice-presidents of research and development or the chief technology officers of approximately 4000 mostly large firms from a wide range of sectors and countries. 940 firms completed most of the 11-page survey for a general response rate of 25% (Floricel, Dougherty, Miller, & Ibanescu, 2008; Floricel & Ibanescu, 2008: p.460).

We use a subset of the survey data to measure the relative importance of five actors on innovation intermediation outcomes. As only 499 firms answered the pertinent questions, we conduct bias tests to compare the characteristics of the firms in the study sample of 499 firms to the characteristics of firms in the full sample. In our bias tests we consider 12 variables including five general variables that reflect the

firm size, rate of growth, profitability, investment in R&D, and investment in human resource; three industry-cluster variables (science-based industries, large-scale industries, and high-competitive industries); and four country variables (Canada, the United States, China, and South Korea). The three industry clusters were identified using cluster analysis on another 10 variables that captured industry characteristics because not all firms responded to the industry membership question at the end of the survey. Firms in the science-based industries cluster include firms with high level of scientific content in products and services (e.g. electrical equipment manufacturers, computer system designers, aerospace product manufacturers, architectural, engineering and related service providers, and management, scientific and technical consulting service providers). Firms in the large-scale industries cluster include firms with stable technical knowledge bases and that experience a high level of regulatory intervention and government support (e.g. basic chemical manufacturers, pharmaceutical and medicine manufacturers, semiconductor manufacturers, and transportation manufacturers). Firms in the highly competitive industries cluster include firms that are cost sensitive and that face severe competition in markets (e.g. software publishers, management, scientific and technical consulting service providers, architectural, engineering and related service providers, and automotive manufacturers).

As shown in Table 2 below, the study sample is biased. Compared to the omitted sample, the firms in study sample have less R&D investment over sales and a lower proportion of the total time and energy of employees devoted to innovation than firms in the omitted sample, but higher annual sales growth and average net profit on sales over the last three years. The results of chi-square tests show that the differences between the proportions of firms in three industry clusters are not statistically significant, so the bias of the study sample is not caused by industry membership. But there is a high proportion of firms from Asia in the study sample, and a high proportion of firms from North America in omitted sample. As the growth in GDP of Asian countries has been higher than the growth of GDP in North American countries in recent years, and as Asian firms are considered to be less innovative than Western firms (Breznitz & Murphree, 2011; Gu & Lundvall, 2006), the differences in firm nationalities in the study

and omitted samples may explain the differences in the general variables in the two samples. As a consequence of this sample bias, care must be taken in the interpretation of our results.

Table 2: Bias Tests Comparing Study Sample to Omitted Sample

Variable	N	Test	Result
General Variables			
1. R & D investment over sales	714	2-sample t-test	-2.69**
2. Number of employees	714	2-sample t-test	1.51
3. Time and energy of the firm's employees that is devoted to innovation	714	Mann-Whitney test	2.04**
4. Annual sales growth	714	Mann-Whitney test	-2.30**
5. Average net profit	714	Mann-Whitney test	-3.89**
Industry Variables			
6. Proportion of firms in science-based industries	186	Chi-square test	0.00
7. Proportion of firms in large-scale and stable technology industries	182	Chi-square test	1.00
8. Proportion of firms in highly competitive industries	375	Chi-square test	0.73
Country Variables			
9. Proportion of firms in Canada	302	Chi-square test	126.01***
10. Proportion of firms in the United States	178	Chi-square test	1.09
11. Proportion of firms in China	201	Chi-square test	156.55***
12. Proportion of firms in South Korea	60	Chi-square test	7.82**

**$p < .01$
*** $p < .001$

Measures

Outcome importance. The importance of each of the ten innovation intermediation outcomes is represented as a dependent variable that is measured on a scale of 1 to 7 in the survey (1: Not at all important; 7: Extremely important). As shown in Table 3 below, two learning outcomes, namely, helping firms learn about new technologies (mean=5.21) and helping firms learn about new markets (mean=4.98), are considered most important. In contrast, the outcomes of coercive processes, namely, forcing firms to innovate by regulations (mean=3.78) and forcing firms to innovate through social pressure (mean=3.51), are considered least important.

Table 3: Dependent and Control Variables Descriptive Statistics

Variables	Min	Max	Mean	SD
Dependent Variables				
Helps learn new technology	1	7	5.21	1.22
Helps learn new markets	1	7	4.98	0.87
Provides with business advice	1	7	4.49	0.85
Identifies knowledgeable people	1	7	4.61	1.02
Undertakes innovative activities	1	7	4.39	1.16
Identifies partner firms and organizations	1	7	4.61	1.13
Facilitates collaboration	1	7	4.31	1.14
Promotes enabling standards	1	7	3.39	0.87
Forces innovation by regulations	1	7	3.78	1.51
Forces innovation by social pressure	1	7	3.51	1.82
Control Variables				
Number of employees (firm size)	1	360000	13095	42591
Annual sales growth	1	6	4	1
Net profit over sales	1	6	3	1
R&D investment	0	100	13.18	17.18
HR investment	1	8	4	2

Actor importance. For each innovation intermediation outcome, respondents were asked to identify the actors that were important to the achievement of that outcome. Actor importance equals 1 if actor i is important for outcome j, and 0 otherwise. Figure 1 indicates the mean values of actor importance for each of the 10 innovation intermediation outcomes. Taking the mean value of 0.3 as a threshold above which actors play an important role in achieving outcomes, we identify that firms are important to the achievement all outcomes except undertaking innovation activities (mean=0.25), promoting enabling standards (mean=0.23), and innovation necessitated by changing regulations (mean=0.12) or social pressure (mean=0.16); governments are important to the achievement of the outcomes of innovation necessitated by changing regulations (mean=0.71) and social pressure (mean=0.48); universities are important to the achievement of technology-related learning (mean=0.52), the identification of knowledgeable people (mean=0.43), and the undertaking of innovation activities (mean=0.39); and industry associations play a role that parallels that of firms. The highlighted text is not correct. Here we are talking about important actors, not the most important actors. For instance, governments are important for the achievement of four outcomes. Please correct this text and the text regarding unimportant actors below but keep the English corrections I have made. Conversely, taking the value of 0.1 as a threshold below which actors play an unimportant important role in achieving outcomes, we

identify that firms, governments, and industry associations are always above the threshold and so never considered as unimportant; that universities are unimportant for the achievement of market-related learning (mean=0.08) and innovation necessitated by changing regulations (mean=0.04) or social pressure (mean=0.08); and that research institutes are considered unimportant for the achievement of innovation necessitated by changing regulations (mean=0.05) and social pressure (mean=0.10).

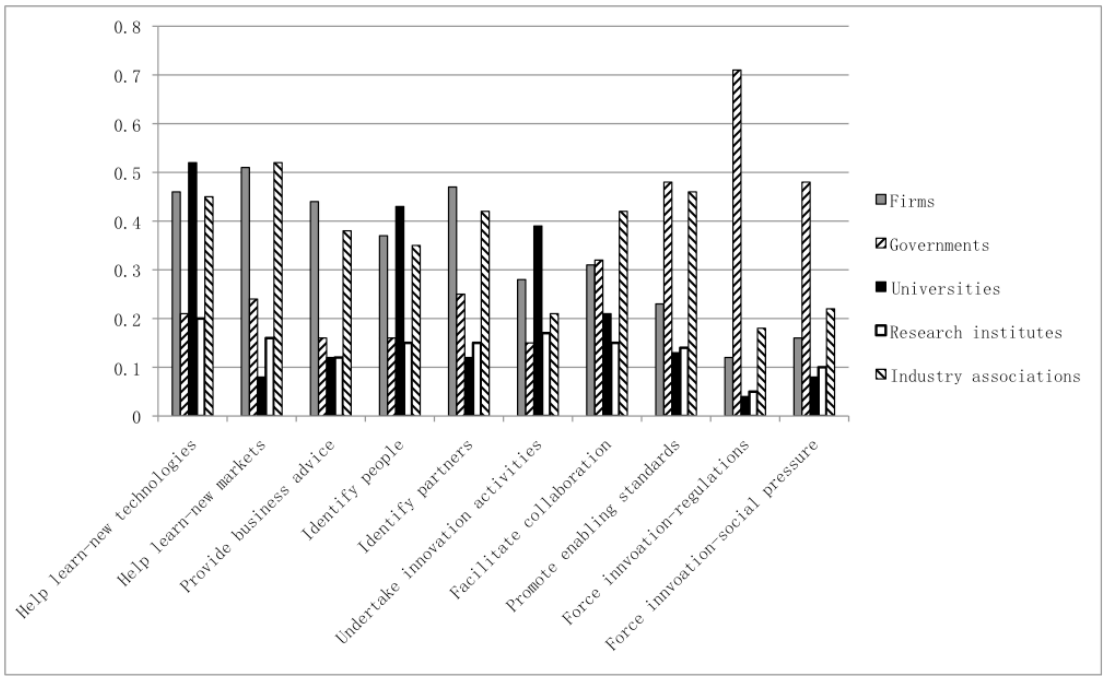

Figure 1: Mean Values of Actor Importance for Ten Innovation Intermediation Outcomes

In addition to the dependent and independent measures, we control for firm attributes. We consider five variables that are measures of the firm size (number of employees), rate of growth (annual sales growth over the last three years), profitability (average net profit over the last three years), and innovativeness (investments in human resources and investments on R&D). We use the natural logarithm of the number of employees because we expect the effect of size to increase at a diminishing rate. Descriptive statistics on control variables are shown in Table 3 above.

We also examine the matrix of correlations between the variables in each of the ten models that include one dependent variable, five independent variables, and five control variables[1]. There are high correlations between the dependent variable and the corresponding independent variables in some cases, but the correlations amongst the independent variables are generally low (below 0.3 in all cases). The low correlations between independent variables suggest satisfactory discriminant validity (Cohen et al., 2003). Variance inflation factors for each of the ten models are all less than five, well below the cutoff of 10 (Draper & Smith, 1998), suggesting that the multi-collinearity is not a problem.

Rationale of Analytic Approach

We use ordinal logistic regression to test the relationships between innovation intermediation outcomes and organizational actors. The assumption of normally distributed dependent variables does not hold in our case as the dependent variables are measured on a 7-point scale. Thus, we use ordinal logistic regression as it makes no assumption about the distribution of dependent variable and allows dependent variables to be either continuous or discrete. Its primary assumption is the proportional odds assumption (Ruefli & Wiggins, 2003), and we test this assumption in our models using chi-square tests that examine whether the proportional odds assumption is violated. The results of chi-square tests are significant, indicating that the assumption (except in the case of Model 10) has been violated (Wang & Schaan, 2008). To remedy this we modify the ordinal logistic regression by merging adjacent values of the dependent variable (Strömberg, 1996). Given *N* possible values of the dependent variable, the number of merged groups may range from 2 to *N* (Greenland, 1993). For each model, we find the first merging scheme for which the p value of the Chi-square test exceeds the cutoff 0.05, indicating that the proportional odds assumption has been met[2].

[1] The table of correlations is not shown but is available from the authors.

[2] Details are available from the authors.

RESULTS

To test our hypotheses we use the results of the ordinal logistic regression shown in Table 4. For example, Model 1 shows that universities are the actor most strongly associated with the outcome "Assistance with learning about technology" as the corresponding coefficient is the largest and the most statistically significant (Model 1: β=0.72, $p < .001$).

Hypothesis 1 states that for-profit firms are the actor most strongly associated with the facilitation of business-related learning, specifically learning about new markets and the provision of business advice. Firms are the most important actors in helping other firms learn about new markets (Model 2: β=0.85, $p < .001$), providing other firms with business advice (Model 3: β=0.70, $p < .001$), and identifying partner firms and organizations (Model 6: β=0.99, $p < .001$). This suggests that for-profit firms provide other firms with the access to both business-related and market-related learning and the identification of partners. Therefore, Hypothesis 1 is partially supported.

Table 4: Models of the Relative Importance of Organizational Actors for Each of Ten Innovation Intermediation Processes

Variables	Model 1 Help learn-technology	Model 2 Help learn-market	Model 3 Provide business advice	Model 4 Identify people	Model 5 Undertake innovative activities
Firm	0.63**	0.85***	0.70***	0.68***	0.37*
	(14.59)	(24.70)	(19.08)	(17.20)	(4.30)
Government agency	0.13	0.32	0.16	0.35	0.30
	(0.47)	(2.45)	(0.55)	(2.55)	(3.37)
University	0.72***	0.43	0.29	1.00***	0.93***
	(19.35)	(1.60)	(3.00)	(36.00)	(30.52)
Research institute	0.71***	0.74**	0.49*	0.48*	0.61**
	(11.70)	(8.28)	(5.48)	(4.34)	(8.10)
Industry association	0.32	0.81***	0.63***	0.63***	0.62**
	(3.96)	(23.12)	(14.55)	(14.01)	(9.60)
Ln(Firm size)	0.02	0.00	0.01	0.01	0.03
	(0.61)	(0.36)	(1.27)	(0.13)	(0.16)
Sales growth	0.08	0.13	0.15*	0.15*	0.10
	(1.54)	(3.47)	(4.81)	(4.89)	(2.83)
R & D investment	0.01	0.01	0.01	0.01	0.00
	(2.53)	(0.86)	(3.47)	(2.24)	(0.68)
HR investment	-0.02	0.03	-0.04	-0.04	-0.04
	(0.10)	(0.22)	(0.49)	(0.50)	(0.46)
Net profit on sales	0.05	-0.03	0.09	0.00	-0.01
	(0.52)	(0.18)	(1.85)	(0.00)	(0.03)
Chi-square	63.51***	76.57***	73.16***	93.22***	59.48***
Nagelkerke R^2	0.12	0.15	0.13	0.17	0.12

Table 4: Models of the Relative Importance of Organizational Actors for Each of Ten Innovation intermediation processes (Continued)

Variables	Model 6 Identify partners	Model 7 Facilitate collaboration	Model 8 Promote enabling standards	Model 9 Force innovation-regulations	Model 10 Force innovation-social pressure
Firm	0.99***	0.55**	0.55**	0.48	0.85***
	(36.74)	(9.87)	(6.85)	(2.06)	(15.36)
Governments	0.55**	0.85***	0.78***	1.44***	1.08***
	(8.62)	(24.36)	(20.83)	(60.16)	(44.75)
University	0.51*	0.87***	0.38	0.58	0.46
	(4.26)	(18.35)	(2.08)	(5.68)	(4.69)
Research institute	0.49*	0.26	0.36	0.57	0.65*
	(6.48)	(1.34)	(2.06)	(2.54)	(5.62)
Industry association	0.75***	1.01***	0.79***	0.75**	0.81**
	(21.87)	(37.35)	(21.30)	(8.70)	(17.91)
Ln(Firm size)	0.03	0.07*	0.08*	0.10*	0.00
	(2.27)	(5.77)	(4.58)	(4.77)	(3.69)
Sales growth	0.17*	0.09	0.13	0.12	0.14*
	(6.29)	(1.82)	(3.15)	(2.89)	(4.45)
R & D investment	0.02**	0.01**	0.00	-0.01*	0.00
	(10.15)	(6.89)	(0.07)	(4.05)	(0.22)
HR investment	-0.05	-0.04	-0.06	-0.13*	-0.17**
	(0.74)	(0.57)	(1.05)	(5.30)	(8.85)
Profit on sales	0.08	0.03	-0.02	-0.020	-0.07
	(1.43)	(0.15)	(0.07)	(0.09)	(1.26)
Chi-square	119.88***	128.73***	74.32***	124.80***	114.51***
Nagelkerke R^2	0.21	0.22	0.15	0.22	0.20

* $p < .05$
** $p < .01$
*** $p < .001$

Hypothesis 2 suggests that universities are the actor most strongly associated with the facilitation of technology-related learning, the identification of knowledgeable people, and undertaking innovative activities. As these are the outcomes for which universities are identified as the most important actors – helping firms learn about new technologies (Model 1: β=0.72, p< .001), identifying knowledgeable individuals (Model 4: β=1.00, p< .001), and undertaking innovative activities on behalf of firms (Model 5: β=0.93, p< .001) – Hypothesis 2 is supported. It is interesting to note that universities are also the second most important actor, after industry associations, for the facilitation of collaboration (Model7).

Hypothesis 3 states that government agencies are the actors most strongly associated with the importance of coercive outcomes. Governments are the actors most strongly associated with forcing firms to innovate through regulations or social pressure as government agencies obtain the highest coefficients in Model 9 (β=1.44, $p < .001$) and Model 10 (β=1.08, $p < .001$). Therefore, Hypothesis 3 is supported. Governments are also, like industry associations, important to the promotion of enabling standards (Model 8).

Hypothesis 4 suggests that industry associations are most strongly associated with the importance of facilitation of collaboration. The results show that of the five actors, industry associations are the actor most strongly association with the facilitation of collaboration (Model 7: β=1.01, $p < .001$) and the promotion of enabling standards (Model 8: β=0.79, $p < .001$). Industry associations are not the actors most strongly associated with the identification of partner firms and organizations (Model 6), so Hypothesis 4 is not fully supported. But it is of interest to note that industry associations are the second most important actor for the identification of partner firms and organizations (Model 6), helping firms learn about new markets (Model 2), and providing firms with business advice (Model 3) – the three outcomes with which firms are most strongly associated.

We also analyze the data segmented by sector and region, and summarize the results as follows[3]. When the data is segmented into manufacturing and service sectors, we find that the effect of universities and industry associations is more pronounced in manufacturing sectors than in service sectors. This may be due to the greater research intensity of the manufacturing sector and the greater complexity of manufactured products (Tassey, 2010).

Although research institutes do not emerge as the most important actor for the attainment of any of the ten

[3] The details of analysis are not shown but available from the authors.

innovation intermediation outcomes, the are the second most important actor, after universities, for helping firms learn about technology (Model 1). Furthermore, when the data are segmented into the three industry clusters, namely, science-based industries, large-scale industries, and highly-competitive industries, we find that research institutes are more important in large-scale industries than in the other two clusters. This finding suggests that respondent firms consider research institutes in the cluster with a stable technical knowledge base and a high level of regulatory intervention are more important than research institutes in the other clusters.

When the data is segmented by region, the results show that for-profit firms are more important in North America than in Asia. Innovation patterns vary by country (Freeman, 1995; Nelson, 1993), and researchers have suggested that Chinese society overemphasizes personal trust and ignores institutional trust (Gu and Lundvall, 2006). Thus, for-profit firms in Asia may be weaker than their western counterparts in knowledge sharing. On the other hand, our results show that industry associations are more important in Asia than in North America.

There are three interesting findings related to control variables. First, respondent firms with high rate of sales growth find the provision of business advice (Model 3: β=0.15, $p< .05$), the identification of knowledgeable people (Model 4: β=0.15, $p< .05$), and the identification of partners (Model 5: β=0.17, $p< .05$) important. Such firms may already have significant internal technology and marketing resources and capabilities. Second, large firms consider the facilitation of collaboration (Model 7: β=0.01, $p< .01$), the promotion of enabling standards (Model 8: β=0.01, $p< .05$), and the effect of regulations (Model 9: β=0.01, $p< .05$) important. And finally, R&D intensive firms consider the identification of partners (Model 6: β=0.02, $p< .01$) and the facilitation of collaboration (Model 7: β=0.01, $p< .01$) important, and they are less likely to consider the effect of regulations (Model 9: β=-0.01, $p< .05$) important.

DISCUSSION

This study was motivated by the need for a better understanding of the outcomes of investments in innovation intermediation. As innovation intermediaries have only recently been understood as an overarching class of organizations (Howells, 2006), researchers have not yet developed methodologies for measuring outcomes that are applicable across different types of intermediaries. Outcomes associated with investments in research consortia have been measured using patents (Sakakibara & Branstetter, 2003) and the ability to attract venture capital financing (Feldman & Kelley, 2006) as the dependent variables, while outcomes associated with investments in science parks have been measured using regional employment (Shearmur & Doloreux, 2000) and firm growth in terms of revenues and employment (Löfsten & Lindelöf, 2002) as the dependent variables.

We have employed an approach to considering the impact of innovation intermediation activities that can be applied across intermediary types. By considering a range of immediate outcomes we were able to detect the impact of a wide range of organizational actors on the innovative capacity of the firms in our sample. In this exploratory study we considered the impact of for-profit firms, universities, governments, industry associations, and research institutes. In future research it may be useful to compare the impact of more specific sets of actors such as those active in particular country or region.

Our approach considered the immediate impact of external actors on firm resources and capabilities, specifically on the firm's ability to learn, gain access to expertise, and engage in collaboration. We also considered the impact of regulations and social pressure. By asking respondents about immediate impacts that may be directly attributable to the external actor in question, we minimized the cognitive burden on respondents and the bias in responses. Had we instead asked about the impact of external actors on longer term outcomes such as increased revenues or employment, the respondent would have had to tease out the impact of the contribution of the external actor from the many other factors that

impact firm revenues and employment. Our focus on immediate impacts was inspired by the Oslo Manual guidelines for innovation surveys that suggest asking about information sources and collaboration (OECD, 2005). But the Oslo Manual considers only two potential outcomes of innovation intermediation processes –information sources and collaboration partners – and we considered only ten. In future research it may be useful to enlarge upon this set of possible immediate impacts.

Past research suggests that for-profit firms are the most important sources of information and collaboration (Amara & Landry, 2005; Freel, 2000; Laursen & Salter, 2006; Segarra & Arauzo, 2008; Veugelers & Cassiman, 2005). But our findings suggest that contrary to the findings of studies that use CIS data, for-profit firms are not always the most important actors in intermediating and facilitating innovation. Firms are only the most important business facilitators. Managers should also consider the role of universities in providing assistance in learning about technologies and in identifying knowledgeable individuals, and the role of industry associations in facilitating collaboration. Accordingly, policy makers may wish to consider a wide range of actors when making investments in the facilitation of innovation (Acworth, 2008; Lee et al., 2010; Smedlund, 2006).

Our findings may be influenced by the fact that our sample contained a high proportion of Asian firms. This bias may influence the effect of for-profit firms because when compared to their Western counterparts, Asian firms are weaker in promoting collaborations with other firms (Park & Luo, 2001). But the proportion of Asian firms in our study sample is just slightly (around 10%) higher than the proportion of Asian firms in the full sample, so it is not expected that the bias have a strong influence on our findings presented above.

While our study can only be considered exploratory, our findings suggest that different organizational actors offer different capabilities as innovation intermediaries. We find that firms are identified as the most important business facilitators, universities as the most important technical facilitators, governments

as the most important coercive actors, and industry associations as the most important facilitators of collaboration. We interpret our results to suggest that firms need access to a wide range of external resources and capabilities and that government investments in dedicated innovation intermediaries may well yield the sought-after socio-economic returns.

REFERENCES

Acworth, E. B. (2008). University-industry engagement: the formation of the knowledge integration community (KIC) model at the Cambridge-MIT institute. *Research Policy*, 37, 1241-1254.

Aldrich, H. E. & Sasaki, T. (1995). R&D consortia in the United States and Japan. *Research Policy,* 24, 301-316.

Amara, N. & Landry, R. (2005). Sources of information as determinants of novelty of innovation in manufacturing firms: evidence from the 1999 statistics Canada innovation survey. *Technovation*, 25, 245-259.

Arundel, A. (2007). Innovation survey indicators: What impact on innovation policy? In OECD, Science, Technology and Innovation Indicators in a Changing World: Responding to Policy Needs (pp. 49-64). Paris: OECD .

Azoulay, P. (2004). Capturing knowledge within and across firm boundaries: Evidence from clinical development. *American Economic Review*, 94(5), 1591-1612

Baum, J.A.C., Calabrese, T., & Silverman, B.S. (2000). Don't go it alone: Alliance networks and startup performance in Canadian biotechnology. *Strategic Management Journal*, 21(3), 267-294.

Bennett, R. J. & Robson, P. J. (1999). The use of external advice by SMEs in Britain. *Entrepreneurship and Regional Development*, 11, 155-180.

Breznitz, D. & Murphree, M. (2011). *Run of the red queen: Government, innovation, globalization, and economic growth in China.* NH: Yale University.

Chesbrough, H. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Press.

Christmann, P. (2000). Effects of "best practices" of environmental management on cost advantage: The role of complementary assets. *Academy of Management Journal*, 43, 663-680.

Cohen, J., Cohen P., West, S.G., & Aiken, L.S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Cohen, W. L. & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1), 128-152.

Czarnitzki, D., Hanel, P., & Rosa, J.M. (2011). Evaluating the impact of R&D tax credits on innovation: A microeconometric study on Canadian firms. *Research Policy,* 40(2), 217-229.

Dalziel, M. (2006). The impact of industry associations. *Innovation: Management, Policy and Practice,* 8, 296-306.

Dalziel, M. (2007). Games of innovation: The roles of nonprofit organizations. *International Journal of Innovation Management,* 11(1), 1-24.

Dasgupta, P. & David. P.A. (1994). Toward a new economics of science. *Research Policy,* 23, 487-521.

Debackere, K. & Veugelers, R. (2005). Improving industry science links through university technology transfer units: an analysis and a case. *Research Policy,* 34(3), 321-342.

Draper, N. R. & Smith, H. (1998). *Applied regression analysis*. New York: Wiley Series in Probability and Statistics.

Dougherty, D. (1990). Understanding new markets for new products. *Strategic Management Journal,* 11, 59-78.
Dyer, J. H. & Hatch, N. W. (2006). Relation-specific capabilities and barriers to knowledge transfers: Creating advantage through network relationships. *Strategic Management Journal*, 27, 701-719
Etzkowitz, H. & Leydesdorff, L. (2000). The dynamics of innovation: from national systems and "mode 2" to a triple helix of university-industry-government relations. *Research Policy*, 29, 109-123.
Feldman, M. P. & Kelley, M. R. (2006). The ex ante assessment of knowledge spillovers: government R&D policy, economic incentives and private firm behavior. *Research Policy*, 35(10), 1509-1521.
Floricel, S., Dougherty, D., Miller, R., & Ibanescu, M. (2008). Networks structures and the production of resources for sustainable innovation. *International Journal of Management,* 41, 379-406.
Floricel, S. & Ibanescu, M. (2008). Using R&D portfolio management to deal with dynamic risk. *R&D Management,* 38(5), 452-467.
Freel, M. S. (2000). External linkages and product innovation in small manufacturing firms. *Entrepreneurship and Regional Development,* 12, 245-266
Freeman, C. (1995). The national system of innovation in historical perspective. *Cambridge Journal of Economics*, 19, 5–24.
Fuchs, E. (2010). Rethinking the role of the state in technology development: DARPA and the case for embedded network governance. *Research Policy*, 39, 1133-1147.
Garud, R., Jain, S., & Kumaraswamy, A. (2002). Institutional entrepreneurship in the sponsorship of common technological standards: The case of Sun Microsystems and Java. *Academy of Management Journal*, 45, 196-214.
Gawer, A. & Cusumano, M. A. (2002). *Platform leadership: How Intel, Microsoft, and Cisco drive industry innovation*. Boston, MA: Harvard Business School Press.
Gooderham, P. N., Tobiassen, A., Døving, E., & Nordhaug, O. (2004). Accountants as sources of business advice for small firms. *International Small Business Journal*, 22(1), 5–20.
Gu, S. L. & Lundvall. B-A. (2006). China's innovation system and the move toward harmonious growth and endogenous innovation. *Innovation Management Policy & Practice*, Volume 8, June.
Gulati, R. (1998). Alliances and networks. *Strategic Management Journal*, 19(4), 293-317.
Gregorio, D. & Shane, S. (2003). Why do some universities generate more start-ups than others? *Research Policy,* 32, 209-227.
Greenland, S. (1993). Alternative models for ordinal logistic regression. *Statistics in Medicine*, 13, 1665-1677.
Grindley, P., Mowery, D.C., & Silverman, B. (1994). SEMATECH and collaborative research design: lessons in the design of high-technology research consortia. *Journal of Policy Analysis and Management,* 13, 723-758.
Grossman, J. H., Morgan, R. P., & Reid, P. P. (2001). Contributions of Academic Research to Industrial Performance in Five Industry Sectors. *The Journal of Technology Transfer*, 26(1-2), 143-152.
Hackett, S.M. & Dilts, D.M. (2004). A systematic review of business incubation research. *The Journal of Technology Transfer*, 29, 55–82.
Hargadon, A. & Sutton, R. (1997). Technology brokering and innovation in a product development firm. *Administrative Science Quarterly,* 42, 718-749.
Howells, J. (2006). Intermediation and the role of intermediaries in innovation. *Research Policy,* 35, 715-728.
Human, S. E. & Provan, K. G. (1997). An emergent theory of structure and outcomes in small-firm strategic manufacturing networks. *Academy of Management Journal,* 40, 368-403.
Hyvattinen, H. (2006). Interface standards and creating innovation markets—implications on SMEs in a technology programme. *Technovation*, 26, 262-273
Iansiti, M. & Levien, R. (2003). *The new operational dynamics of business ecosystems: Implications for policy, operations, and technology strategy*. Boston, MA: Harvard Business School Press.
Jenson, R. & Thursby, M. (2001). Proofs and prototypes for sale: The licensing of university inventions. *American Economic Review,* 91, 240-259.

Kennedey, S. (2008). *The business of lobbying in China*. MA: Harvard University Press.
King, A. A. & Lenox, M.J. (2000). Industry self-regulation without sanctions: the Chemical Industry's Responsible Care Program. *Academy of Management Journal,* 43(4): 698-716.
Klepper, S. (2007). Disagreements, spinoffs, and the evolution of Detroit as the capital of the U.S. automobile industry. *Management Science,* 50(4), 616-631.
Kline, S.J. & Rosenberg, N. (1986). An overview of innovation. In: Landau, R., Rosenberg, N. (Eds.), The positive sum strategy: Harnessing technology for economic growth (275-306). Washington DC: National academy press.
Laursen, K. & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal*, 27, 131-150.
Lee, S., Park, G., Yoon, B., & Park, J. (2009). Open innovation in SMEs-an intermediated network model. *Research Policy*, 39, 290-300.
Lerner, J. (1999). The government as venture capitalist: the long-run impact of the SBIR program. *Journal of Business*. 72(3), 285-318
Levinthal, D. & March, J.G. (1993). The myopia of learning. *Strategic Management Journal*, 14, 95-112.
Li, H. Y. & Atuahene-Gima, K. (2002). The adoption agency business activity product innovation, and performance in Chinese technology ventures. *Strategic Management Journal,* 23, 469-490.
Löfsten, H. & Lindelöf, P. (2002). Science parks and the growth of new technology-based firms-academic-industry links, innovation and markets. *Research Policy,* 31, 859-876.
Matt, M. & Wolff, S. (2004). Incentives, coordination and learning in government-sponsored vs. spontaneous inter-firm research cooperation. *International Journal of Technology Management*, 27 (8), 694-711.
Motohashi, K. & Yun, X. (2007). China's innovation system reform and growing industry and science linkages. *Research Policy,* 36, 1251-1260.
Murmann, P. (2003). *Knowledge and competitive advantage: The coevolution of firms, technology, and national institutions.* Cambridge University Press, Cambridge UK.
Muscio, A. (2010). What drives the university use of technology transfer offices? Evidence from Italy, *The Journal of Technology Transfer*, 35, 181-202.
Nelson, R. (1993). *National innovation systems: a comparative analysis*. NY: Oxford University Press.
OECD. (2005). *Oslo manual: guidelines for collecting and interpreting innovation data, 3rd Edition*.
Park, S. H. & Luo, Y. (2001). Guanxi and organizational dynamics: Organizational networking in Chinese firms. *Strategic Management Journal,* 22(5), 455-477.
Perkmann, M. & Walsh, K. (2008). Engaging the scholar: Three forms of academic consulting and their impact on universities and industry. *Research Policy*, 37, 1884-1891.
Porter, M. E. & Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives,* 9(4), 97-118.
U.S. National Research Council. (1999). *U.S. research institutes in the mathematical sciences*. National Research Council.
Rogers, J. D. & Bozeman, B. (1997). Basic research and the success of federal lab-industry partnerships. *The Journal of Technology Transfer*, 22(3), 37-47.
Rosenkopf, L., Metiu, A., & George, V. P. (2001). From the bottom up? Technical committee activity and alliance formation. *Administrative Science Quarterly,* 46, 748-772.
Rothaermel, F. T. & Thursby, M. (2005). University-incubator firm knowledge flows: Assessing their impact on incubator firm performance. *Research Policy,* 34, 305-320.
Rowe, R.B. & Temple, S. D. (2011). Superfilling technology: transferring knowledge to industry from the National Institute of Standards and Technology. *The Journal of Technology Transfer*, 36(1), 1-13
Ruefli, T. W. & Wiggins, R. R. (2003). Industry, corporate, and segment effects and business performance: a non-parametric approach. *Strategic Management Journal,* 23, 861-879.
Sakakibara, M. & Branstetter, L. G. (2003). Measuring the impact of US research consortia. *Managerial and Decision Economics,* 24, 51-69.

Salazar, M & Holbrook, A. (2004). A debate on innovation surveys. *Science and Public Policy*, 31(4), 254-266.
Salter, A.J. & Martin, B.R. (2001). The economic benefits of publicly funded basic research: A critical review. *Research Policy*, 30(3), 509-532.
Sampson, R. (2007). R&D alliances and firm performance: The impact of technological diversity and alliance organization on innovation. *Academy of Management Journal,* 50(2), 364-386.
Sapsed, J., Grantham, A., & DeFillippi, R. (2007). A Bridge over troubled waters: bridging organizations and entrepreneurial opportunities in emerging sectors. *Research Policy,* 36, 1314-1334.
Segarra, A. & Arauzo, J.M. (2008). Sources of innovation and industry–university interaction: Evidence from Spanish firms. *Research Policy,* 37, 1283–1295.
Shapiro, C. & Varian, H. (1999). *Information Rules*. MA: Harvard Business School Press.
Sharma, S. & Henriques, I. (2005). Stakeholder influences on sustainability practices in the Canadian forest products industry. *Strategic Management Journal*, 26(2), 159–180.
Shearmur, R. & Dolorux, D. (2000). Science parks: actors or reactors? Canadian science parks in their urban context. *Environment and Planning A*, 32, 1065-1082.
Siegel, D. S., Waldman, D., & Link, A. (2003). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: An Exploratory study. *Research Policy,* 32, 27-48.
Sine, W. D., Haveman, H. A., & Tolbert, P. S. (2005). Risky business? Entrepreneurship in the new independent-power sector. *Administrative Science Quarterly,* 50(2), 200-232.
Smedlund, A. (2006). The roles of intermediaries in a regional knowledge system. *Journal of Intellectual Capital,* 7(2), 204-220.
Sorensen, J. & Chambers, D. (2008). Evaluating academic technology transfer performance by how well access to knowledge is facilitated - defining an access metric. *The Journal of Technology Transfer*, 33(5), 534 – 547.
Strömberg, U. (1996). Collapsing ordered outcome categories: A note of concern. *American Journal of Epidemiology,* 133(3), 321-323.
Svensson, R. (2007). Knowledge transfer to emerging markets via consulting projects. *The Journal of Technology Transfer,* 32(5), 545-569.
Tassey, G. 2010. Rationales and mechanisms for revitalizing US manufacturing R&D strategies. *The Journal of Technology Transfer,* 35: 283-333.
Tether, B. (2001). I*dentifying innovation, innovators and innovative behaviors: A critical assessment of Community Innovation Surveys (CIS).* CRIC Discussion Paper No.48, CRIC, University of Manchester, December.
Veugelers, R. & Cassiman, B. (2005). R&D cooperation between firms and universities: Some empirical evidence from Belgian manufacturing. *International Journal of Industrial Organization*, 23, 355-379.
Von Hippel, E. (1986). Lead users: A source of novel product concepts. *Management Science*, 32(7), 791-805.
Wakasugi, R. & Ito, B. (2007). The effects of stronger intellectual property rights on technology transfer: evidence from Japanese firm-level data. *The Journal of Technology Transfer*, 34(2), 145-158.
Wang, H. L. & Schaan, J. L. (2008). How much distance do we need? Revisiting the "national cultural distance paradox". *Management International Review,* 38(3), 263-278.
Wallsten, S.J. 2000. The R&D Boondoggle: Why is the government subsidizing commercially promising business projects? *Regulation,* 23(4): 12-16.
Weisbrod, B.A. 1991. *The nonprofit economy.* Harvard University Press.
Zhang, Y. & Li, H.Y. (2010). Innovation search of new ventures in a technology cluster: the role of ties with service intermediaries. *Strategic Management Journal*, 31, 88-109.
Zucker, L. G., Darby, M. R., & Armstrong, J. S. (2002). Commercializing knowledge: University science, knowledge capture, and firm performance in biotechnology. *Management Science*, 48(1), 138-153.