No Strings Attached: Examining the Relationship between Loosely Coupled Research Partnerships and Innovative Performance

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Abstract

We examine whether, why and when accessing external knowledge via loosely coupled research partnerships may increase the in-sourcing firm’s innovative performance. We argue that innovation benefits from loosely coupled partnerships (e.g. a research contract, licensing) stem not only from the sourcing relationship per se, but are closely linked to the in-sourcing firm’s experimental orientation to pursue risky projects and its availability of financial slack and managerial resources. We test our hypotheses in the global pharmaceutical industry, using a panel dataset covering the world’s largest global pharmaceutical firms between 1998 and 2007. Our results demonstrate that loosely coupled research partnerships, under certain circumstances, may provide the same type of innovation benefits typically attributed only to tightly coupled partnerships (e.g. a joint venture).

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ABSTRACT

We examine whether, why and when accessing external knowledge via loosely coupled research partnerships may increase the in-sourcing firm’s innovative performance. We argue that innovation benefits from loosely coupled partnerships (e.g. a research contract, licensing) stem not only from the sourcing relationship per se, but are closely linked to the in-sourcing firm’s experimental orientation to pursue risky projects and its availability of financial slack and managerial resources. We test our hypotheses in the global pharmaceutical industry, using a panel dataset covering the world’s largest global pharmaceutical firms between 1998 and 2007. Our results demonstrate that loosely coupled research partnerships, under certain circumstances, may provide the same type of innovation benefits typically attributed only to tightly coupled partnerships (e.g. a joint venture).
INTRODUCTION

Faced with a rapidly changing technological environment, firms are increasingly required to combine knowledge from a range of disciplines which no single firm is likely to possess (Steensma et al., 2000). As a result, inter-firm research partnerships (i.e., partnerships to discover new innovative solutions) have grown substantially in both number and importance in the last decade (Hagedoorn, 2002; Kale et al., 2009; Rothaermel et al., 2004). The intent behind these exploration types of partnerships (Koza et al., 1998) is to accelerate the yield from research assets by reducing innovation cycle times and gaining access to valuable new elements of knowledge (Laursen et al., 2010; Leone et al., 2012; Rosenkopf et al., 2003).

While research partnerships in general have been increasing, in this paper we focus on those partnerships in which there is a low level of mutual commitment and interdependence between partners, as exemplified by research contracts or licensing agreements. These types of research partnerships, which we call loosely coupled (Orton et al., 1990; Steensma et al., 2000; Thompson, 1967) often involve one firm paying to have access to specific knowledge from another firm and to reuse such knowledge created by the research partner (Murray et al., 2007). Despite their importance and prevalence, loosely coupled partnerships are in sharp contrast with tightly coupled partnerships (Steensma & Corley, 2000), which rely on the reciprocal exchange of knowledge (Eisenhardt et al., 1996), high levels of commitment among the partners and the generation of partnership-specific assets (e.g., joint product development agreements or equity joint ventures) (Sampson, 2007).

Previous studies have consistently shown the benefits of tightly coupled partnerships based on the fact that innovation more often than not requires the reciprocal exchange and recombination of knowledge from the cooperating parts (Dyer et al., 1998; Mowery et al., 1996).
In a related vein, it has also been suggested that simply “handing off” research from one partner to another may not be enough to allow the in-sourcing firm to innovate (Eisenhardt et al., 1996). Given that loosely coupled research partnerships (e.g., licensing deals and research contracts) typically lack those strong reciprocal interdependencies and do not rely on mutual knowledge exchange, it should not be entirely surprising that existing empirical evidence indicates a weak relationship between loosely coupled research partnerships and a firm’s ability to develop innovations new to their industry (Fey et al., 2005; Keil et al., 2008; Luo, 2008; Mowery et al., 1996).

It is striking, then, that loosely coupled partnerships are increasingly prevalent in many industries, as exemplified by the widespread use and rapid growth of research contracts and licensing deals at very early stages of the innovation cycle in the pharmaceutical industry (Nicholls-Nixon et al., 2003; Rothaermel et al., 2007). Intrigued by the mismatch between previous findings pointing to the limited potential of loosely coupled partnerships to generate innovations on the one hand, and their prevalence in many industries on the other, we examine in this paper whether, why and when loosely coupled research partnerships may increase a firm’s innovative performance.

It is important to note that our main goal is not to challenge the findings of previous studies that showed the benefits of tightly coupled partnerships. Instead the crux of our paper is to focus exclusively on loosely coupled partnerships and reveal the conditions under which they are more likely to spur the in-sourcing firm’s innovation performance. Researchers have already

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1 This argument is also consistent with the findings in the network literature which shows that despite the importance of weak ties for the identification of new ideas (Granovetter, 1985), strong ties are essential to the transformation of those ideas into actual innovations (Hansen, 1999).

2 As we will detail in the methods section below, our operationalization of innovative performance is the introduction of solutions which are new to the market. This measure is in line with Teece’s (1986) view that the innovator should be the firm that is first to introduce a solution to the market.
suggested that the benefits of loosely coupled partnerships may stem from the in-sourcing firm’s ability to add knowledge variety while at the same time allowing it to remain flexible in a rapidly changing technological environment (Danneels, 2003; Leone et al., 2012; Steensma et al., 2000).

Yet innovation often requires firms to not only access a variety of diverse knowledge provided by external partners but also to experiment and recombine knowledge in novel ways (Levitt et al., 1988), and the length of innovation cycle requires the continued allocation of organizational resources, be they financial or managerial, towards research projects (Adner et al., 2008; Cyert et al., 1963).

Therefore, while loosely coupled partnerships add variety to the in-sourcing firm’s knowledge base and this, per se, is important to innovation, their lack of a reciprocal knowledge exchange may not induce the experimentation necessary to allow that firm to fully benefit from the in-sourced knowledge. Moreover, while loosely coupled partnerships are a flexible mode of in-sourcing external knowledge, resources gained from them are also withdrawn more easily; therefore, they may lack the continued resources necessary to ultimately positively affect the in-sourcing firm’s innovative performance (Luo, 2008; Steensma et al., 2000). It is hence the purpose of this paper to go beyond the mere direct effect of loosely coupled partnerships on innovation performance by examining the conditions under such partnerships are more likely to be fully leveraged to benefit in-sourcing firm.

We argue that the innovation benefits accruing from research partnerships depend on both the external knowledge being in-sourced and the in-sourcing firm’s internal context. More precisely, we suggest that, as a baseline model, loosely coupled partnerships are beneficial to a firm’s innovative performance. We argue, however, that those innovation benefits are more likely to transpire when certain internal firm factors are present. Namely, we hypothesize that the in-
sourcing firm’s experimental orientation (i.e., a firm’s propensity to experiment with projects with novel elements of knowledge to the firm internally) (Ahuja et al., 2001) and its availability of financial and managerial resources (Cyert et al., 1963) positively moderate the impact of loosely coupled partnerships on the in-sourcing firm’s innovative performance.

We test our hypothesis in the global pharmaceutical industry, using a panel dataset covering the world’s largest (Top 50) global pharmaceutical firms between 1998 and 2007 and spanning 454 firm-year observations. In the pharmaceutical industry, the discovery of new solutions is pivotal for firm success (Roberts, 1999) and both types of research partnerships (i.e., tightly and loosely coupled) are widespread. We examine the effect of those loosely coupled research on innovative performance by examining the number of new products in development a focal firm is able to add to its innovation pipeline (Hess et al., 2011).

As we discuss in detail below, our results suggest only a weak direct effect of loosely coupled partnerships on a firm’s innovative performance. More interestingly, though, we also show if the in-sourcing has an experimental orientation, it can work as a catalyst for using and experimenting with external knowledge accessed through the loosely coupled partnerships. In a similar vein, we show the importance of having managerial and financial resources to fully benefit from loosely coupled partnerships. Taken together, our results indicate that while the mere existence of loosely coupled partnerships may not be enough for a firm to become more innovative, under certain conditions, those same loosely coupled partnerships are able to lead to the innovation outcomes (in our case, new product candidates representing solutions new to the in-sourcing firm’s industry) typically only attributed, in previous studies, to tightly coupled partnerships (Laursen et al., 2010; Leone et al., 2012). The paper hence contributes to the
growing literature on the role of loosely coupled partnerships and emphasizes their role in innovation attempts that go beyond the exploitation of existing knowledge.

THEORY

Accessing knowledge through research partnerships

Firms can access external knowledge through research partnerships in various ways. A common distinction that we adopt in this paper is based on the level of interorganizational dependence and the level of joint commitment among research partners (Gulati et al., 1998; Koza et al., 1998). Tightly coupled partnerships are characterized by strong interdependencies in which firms rely on the reciprocal exchange of knowledge (Ahuja, 2000; Dyer et al., 1998; Gulati et al., 1998). This is exemplified by joint ventures, where partners commit resources and equity to form a completely new organizational entity, or by research alliances in which partners share scientific personnel, engineers and management or share resources for joint research (Kale et al., 2009; Mowery et al., 1996). Conversely, loosely coupled partnerships represent forms of accessing knowledge that predominantly rely on the sequential interdependence among the partners (Gulati et al., 1998; Luo, 2008). As much as in extreme cases, loosely coupled partnerships may be limited to an exchange of knowledge for money as exemplified by a pure in-licensing contract, where one firm will use the knowledge of another firm with limited further interaction (Anand et al., 2000; Murray et al., 2007), in most cases the loosely coupled partnership involve an on-going relationship between research partners. Other examples include research contracts through which firms define their research needs ex ante.
The defining characteristic of those research partnerships is the lack of mutual collaboration and of a bi-directional exchange of knowledge. In a loosely coupled partnership, one partner can be clearly identified as the firm receiving knowledge (i.e., the in-sourcing firm) from the other partner, which typically receives some sort of financial compensation.

Loosely coupled partnerships and innovative performance

Loosely coupled research partnerships are believed to add variety to a firm’s knowledge repertoire, which is conducive for innovation. Yet, surprisingly little research has empirically investigated the impact of this type of research partnership on the in-sourcing firm’s innovative performance.

We posit that loose coupling has desirable benefits for an in-sourcing partner; to the extent that they provide immediate access to specialized knowledge from external partners. Engaging in such partnerships adds variety to a firm’s repertoire of knowledge, which is important to finding new innovative solutions (Laursen et al., 2010). They also provide a firm with flexibility in their research projects as those partnerships are quickly initiated and require lower set-up costs (i.e., loosely coupled partnerships tend to not generate costly and partner-specific resources and routines) (Zollo et al., 2002). This allows firms to move quickly once new technologies emerge and to abandon those rendered obsolete (Luo, 2008; Steensma et al., 2000). Consequently, many researchers have considered loosely coupled partnerships as valuable options in environments characterized by high technological uncertainty and change, where for every successful innovation, many failures are likely to occur (Folta, 1998). Recently,

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3 Although firms may engage in other formal transactions to gain access to external knowledge (e.g., corporate venture capital investments), tightly and loosely coupled research partnerships represent the vast majority of knowledge-access transactions (Dushnisky et al., 2010)
researchers have started to examine in more detail the role of loosely coupled partnerships (e.g., by examining licensing contracts) on innovative performance and have found that licensing-in technologies accelerate the introduction of new inventions (Leone & Reichstein, 2012) and allows firms to subsequently search for and add more knowledge variety (Laursen et al., 2010). Given that firms require a large pool of potential solutions at their disposal and the flexibility to react to emerging technological trends, we suggest that loosely coupled research partnerships should positively affect a firm’s innovative performance. More formally, we hypothesize that

**Hypothesis 1: Loosely coupled research partnerships increase the in-sourcing firm’s innovative performance.**

**High level of experimentation, financial and organizational resources: the fertile ground for loosely coupled partnerships to flourish**

We argue that firms accessing external knowledge through loosely coupled partnerships may accumulate sufficient distinct elements of highly specialized knowledge, yet may still not experience an increase in their innovative performance unless they are able to recombine this knowledge in novel ways through experimentation and support the partnerships through both financial and managerial resources. More specifically, in the following sections, we examine how accessing knowledge through loosely coupled partnerships interacts with the in-sourcing firm’s ability to recombine knowledge in novel ways (its “experimental orientation”), and how the availability of managerial resources and financial slack plays a critical role in allowing the in-sourcing firm to fully benefit from its loosely coupled partnerships.
Experimental Orientation: Firms differ in their willingness to take risks and experiment with new elements of knowledge. We suggest that a firm’s high experimental orientation (i.e., a firm’s willingness to pioneer novel solutions) (Ahuja et al., 2001; Miller, 1983) may serve as a catalyst for experimenting with knowledge accessed through loosely coupled research partnerships.

In contrast to tightly coupled partnerships, loosely coupled research partnerships have a clear delineation between sender and receiver, so the flow of knowledge is unilateral. While firms may add specialized new knowledge, the unilateral structure inhibits experimentation, which is best achieved through an iterative and reciprocal exchange of knowledge (Eisenhardt et al., 1996; Galunic et al., 1998). Innovation requires firms to challenge their existing paradigms, which results in firms redefining their heuristics as to how solutions and problems are interconnected (Lei et al., 1996).

Previous research has shown that some firms are more willing than others to experiment and take risks in strategic actions related to market entry or product innovation (Miller, 1983; Roberts, 1999). With respect to innovation, researchers have suggested that firms may either take a more incremental approach to innovation or become a pioneer in offering new solutions as they challenge current industry assumptions (Ahuja et al., 2001). Following this idea, experimental orientation reflects a firm’s willingness to engage in projects where expected returns are not foreseeable (Miller, 1983). This includes but is not limited to top managers’ preferences to engage in risky projects but also is reflected in a firm’s incentive and reward structures (Henderson et al., 1994).

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4. The notion that some firms may be more experimental than others is related to the seminal work March (1991). March’s highlighted that some firms more than others emphasize experimental learning by trying out new ways of solving problems.

5. Experimental orientation through risk taking may be considered as part of a firm’s overall entrepreneurial orientation, which entails other dimensions like proactiveness or competitive aggressiveness (Dess et al., 1997).
We believe firms with a strong experimental orientation are more likely to benefit from their loosely coupled research partnerships since they are skilled at not only handling greater knowledge variety but, at the same time, are able to induce the experimentation required to effectively use this variety for innovation to occur.

First, even though the exchange of knowledge between the partners is predominantly unidirectional, firms with a stronger experimental orientation will be better equipped to subsequently draw upon new external knowledge and recombine it in novel ways. Second, firms with a strong experimental orientation may also provide incentive structures to draw upon knowledge which is not immediately related to the scientists’ current projects and activities. This is more likely to encourage scientists to leverage a broader variety of knowledge (Itami et al., 1991), which again would make loosely coupled partnerships more effective. We suggest that firms with an experimental orientation may accrue stronger benefits from loosely coupled partnerships. More formally, we propose:

Hypothesis 2: The in-sourcing firm’s level of experimental orientation positively moderates the effect of loosely coupled research partnerships on the in-sourcing firm’s innovative performance.

Organizational resources: Generally, firms can only sponsor a limited number of unique problems and solutions simultaneously (Cyert et al., 1963). This requires that they make tradeoffs in allocating resources, be they financial or managerial, among multiple options (Hitt et al., 1996; Voss et al., 2008). As a result, loosely coupled partnerships are most effective when organizational resources are available.
Extant research indicates that organizational resources impose important boundary conditions (Penrose, 1959) that affect a firm’s ability to absorb and use external knowledge (Ahuja et al., 2001; Ocasio, 1997). These constraints are particularly salient for loosely coupled partnerships. Unlike tightly coupled research partnerships, that quite often have greater dedicated scientific and managerial personnel, loosely coupled research partnerships are characterized by lower levels of such commitment (Zollo et al., 2002). They are also often endowed with fewer overall organizational resources in the first place, which is evidenced by lower governance and administration costs (Contractor, 1990). It is hence likely that such partnerships will lack dedicated managerial personnel who could act as “champions” to promote and defend the partnership and its associated knowledge when, for example, making budget decisions. Moreover, resources committed to such projects rely less on building partner-specific assets to support the innovation process in the long run (Steensma et al., 2000), which limits the commitment associated with such partnerships. The result is that organizational resources can be more easily withdrawn from loosely coupled partnerships, in particular in the presence of alternative paths to develop new innovative products (Adner et al., 2008; Osborn et al., 1990; Sirmon et al., 2008).

We focus on two types of organizational resources: managerial, exemplified by managerial attention (Cyert et al., 1963; Ocasio, 1997; Penrose, 1959) and financial resources, exemplified by liquid resources beyond what is needed to operate the firm in the short term, i.e., financial slack (Singh, 1986; Voss et al., 2008).

Both types of resources can act as catalysts, making loosely coupled partnerships more effective. Innovation is not a one-off event, but a long process that requires firms to continuously commit managerial resources to their research activities and provide access to decision-making
across the organization (Dougherty et al., 1996). Managerial resources such as managerial attention are not scale-free (Levinthal et al., 2010), meaning that firms can usually only attend to a few unique innovation problems. Extant research, for example, indicates that fast-growing firms in one period tend to experience slower growth in ensuing periods due to a lack of managerial resources (Penrose, 1959). In a similar vein, scope-increasing activities are likely to absorb managerial attention, leaving only limited managerial resources available for loosely coupled partnerships.

Conversely, in the presence of limited growth and few alternatives to which resources must be allocated, loosely coupled partnerships are more likely to receive the managerial attention necessary to convert their knowledge into new innovative products. In our empirical setting (pharmaceuticals), firms build large pipelines of product candidates to innovate. Following the idea of managerial resource constraints, an increase in the pipeline of products in development is likely to absorb managerial resources. However, when growth is limited, managerial resources are more likely to be available so that loosely coupled partnerships will be more effective.

Financial resources are also likely to act as a catalyst for loosely coupled partnerships. Cyert and March (1963:189) highlighted that financial slack provides a fundamental role in the innovation process as it “provides a source of funds for innovations that would not be approved in the face of scarcity.” Financial slack indirectly supports the innovation process by influencing the decision context in which resource allocations for innovative projects are undertaken (Greve, 2003; Nohria et al., 1996). Namely, financial slack relaxes the internal monitoring and controls that are critical in a firm’s decision-making environment (Bourgeois III, 1981). The idea is that

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6 Although slack may have many different forms (Voss et al., 2008), researchers have predominantly focused on financial slack in the form of financial reserves as an important resource influencing innovation (Nohria et al., 1996)
slack provides a “cushion” in the event of failure, leading firms to monitor performance less strictly (Cyert et al., 1963:43). Researchers have suggested that slack is necessary to adapt to a changing technological landscape, so that existing resources can complement new innovation activities (Rothaermel, 2001). In a similar vein, researchers have identified that the extent of investible resources, i.e., resources available for firms to invest, imposes an important boundary condition for subsequent firm acquisition activities (Kaul, 2012).

We suggest that the innovation benefits of loosely coupled research partnerships are more likely to materialize in the presence of financial slack in the in-sourcing firm. Financial slack can provide the in-sourcing firm with the ability to resist short-term performance pressures, thus enabling it to continue to commit the necessary financial resources required from its loosely coupled research partnerships (Greve, 2003). Prior research further indicates that slack encourages experimentation(Cyert et al., 1963), which we identified as being particularly important for loosely coupled partnerships. In the event that additional resources are required by other projects, financial slack can serve as a buffer. Thus, loosely coupled partnerships face lower risks that resources will be withdrawn or re-allocated elsewhere. It follows then that the existence of financial slack allows the in-sourcing firm to more fully leverage the knowledge accessed through loosely coupled research partnerships.

Considering these two arguments (the availability of managerial resources and financial slack), we propose that:

_Hypothesis 3: The in-sourcing firm’s level of managerial resources positively moderates the effect of loosely coupled research partnerships on the in-sourcing firm’s innovative performance._
Hypothesis 4: The in-sourcing firm’s level of financial slack positively moderates the effect of loosely coupled research partnerships on the in-sourcing firm’s innovative performance.

METHODS

Setting: Global pharmaceutical industry

We tested our hypothesis in the global pharmaceutical industry and examined innovative performance in terms of new drug development in a given firm’s year. New drug development takes, on average, 7 to 11 years from original discovery to launch (Powell et al., 1996), and is a highly regulated process with clearly defined steps. We focused on the early stage of drug development, which begins with the discovery of the chemical compound (small molecule) or biologically based large molecules. Only 2.5% of all drug compounds become lead candidates to enter the preclinical stage, where they are tested in the laboratory or with animals (Giovannetti et al., 2000; Hess et al., 2011). This innovation cycle allowed us to clearly distinguish between discovery (everything prior to preclinical trials) and development (preclinical and beyond).

Sample

We compiled a unique database, merging data from ReCap, Pharmaprojects, Adis R&D Insights and Compustat to track firms’ efforts to access external knowledge and drugs in development from a sample of established biotechnology and pharmaceutical firms. Pharmaprojects and Adis R&D Insights are databases tracking new drug development in the pharmaceutical industry and have been used in prior research studies (Adegbesan et al., 2011; Hess et al., 2011).

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7 Recombinant Capital (ReCap), a proprietary database tracking the life science industry, is considered to be one of the most comprehensive publicly available data sources for the industry (Schilling, 2009).
Our sample was based on a comprehensive list of publicly traded firms in the pharmaceutical industry. We opted to use 1997 as a starting point (1 year before our 10 year study period) and queried the Top 50 research active firms based on compounds in development in Pharmaprojects. To be included in our sample a firm had to have at least one compound launched as a new molecular entity (or biologic) drug in Pharmaprojects before. We did not capture those firms predominantly focused on formulation technologies or generics. Our study is interested in the effect of external research agreements and all Top 50 Bio-pharmaceutical engaged at least in one loosely coupled inter-organizational agreement in ReCap.

For each firm, we constructed a detailed history of divisions and subsidiaries using the Directory of Corporate Affiliations, LexisNexis and corporate websites to ensure that we allocated each drug and collaboration to the right firm at the right time. The total sample consisted of 50 firms, which span 454 observations from 1998 to 2007.

Measures

Dependent Variables

Innovative performance:

New product development starts as a process of discovering new knowledge and the transformation of such knowledge in a final product (Madhavan et al., 1998). Given the length of the innovation cycle we opted to examine an intermediate output of the product development process as a proxy for innovative performance. Namely, we examined new products in development as a dependent variable. New products in development represent a key stage in the

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8 This includes firms that do not belong to the bio-pharmaceutical industry per SIC code but are considered to be among the Top 50 pharmaceutical firms worldwide according to Pharmaceutical Executive. We identified 4 horizontal mergers (e.g., Astra AB and Zeneca forming AstraZeneca) for which we combined the data of the two merging firms. To keep a sample of 50 we added 4 firms, until rank 54.
innovation process as they reveal a firm’s ability to recombine various types of knowledge and have been used in prior research to measure a firm’s innovativeness (Hess et al., 2011; Rothaermel et al., 2004; Shan et al., 1994). Given that the ultimate goal of firms through loosely coupled partnerships is to find a potential product candidate, we considered this intermediate output as appropriate to capture if firms can ultimately benefit from loosely coupled partnerships.9 Using Pharmaprojects, we counted the annual number of new products in preclinical trials (Innovative performance) that were introduced by the firm in a given year. We used the new chemical entity flag provided by Pharmaprojects to identify innovations new to an industry (i.e., the molecule or biologic that represents a new solution to address a therapeutic need).10 For each preclinical compound, we manually checked the date in Pharmaprojects to identify when the firm first put this compound in preclinical development. We used a second database (Adis R&D Insights) to verify or complement missing data for when a drug entered preclinical testing. We used the earliest reported date in cases when the databases differed. On average, firms introduce 5.4 new molecular entities (including chemical and biologics) into preclinical development each year.

**Independent Variables**

**Loosely coupled research partnerships:** We used ReCap to capture loosely coupled research partnerships. We only counted agreements that were signed at the earliest research stage. These agreements are flagged in Recap as “discovery” based on when the partnership was signed. At the discovery stage, firms usually have not yet found an actual compound to be used

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9 Counting the number of patents used as in prior studies may be misleading as firms through loosely coupled partnerships may actually access rights to use certain patents but not necessarily need to increase their patenting output themselves. Important insights gained from loosely coupled partnerships like validating biological targets and new mechanism of actions in the human body cannot be patented.

10 We also counted biological drugs as new to the industry but excluded biosimilars and generic drugs.
for further testing and quite often only have an idea of what mechanism in the body the potential discovery should target (Rydzewski, 2008). To ensure that we only captured agreements in which the research partners had the intention to generate new knowledge, we excluded any partnership that addressed reformulations of existing drugs or new combinations of existing substances.\textsuperscript{11}

Following extant work on partnerships (Lavie, 2007; Stuart, 2000), we acknowledged that the effect of accessing external knowledge may not be instantaneous. We used a four year stock of innovative partnerships, reflective of the project time common for early stage research initiatives (Rydzewski, 2008).\textsuperscript{12} We followed common conventions when studying the effect of interorganizational agreements on performance (Lavie, 2007; Stuart, 2000) and tested both a depreciated and undepreciated stock of partnerships.\textsuperscript{13} We reported the undepreciated four year stock in the results, which are almost identical to using a depreciated measure. More importantly, we operationalized \textit{Loosely Coupled Research Partnerships} as the number of research agreements, which we could unambiguously classify as signed during the discovery stage in the last four years wherein the in-sourcing firm enters a research partnership in order to access knowledge from a partner in exchange for money. We define loosely coupled partnerships in our sample as either in-licensing (Recap code L)\textsuperscript{14} and research contracts (Recap code R) with the in-sourcing firm financing and paying royalties for research and technologies of a partner.\textsuperscript{15} We identified 770 such agreements initiated by the 50 sample firms between 1994 and 2006.\textsuperscript{16}

\textsuperscript{11} Results are robust keeping these agreements.
\textsuperscript{12} Results are robust using 4 and 5 years respectively.
\textsuperscript{13} Depreciation of the stock of bilateral partnerships reflects that recent sourcing activities might have a stronger effect than research agreements announced at an earlier point in time.
\textsuperscript{14} 85\% of all the research agreements had a licensing component.
\textsuperscript{15} Some of those research partnerships were classified as “pure licensing,” quite often involving a one-off purchase of knowledge (e.g., patent) by the in-sourcing firm. We believe these are extreme cases of a loosely coupled
Moderators

Experimental Orientation: Following the literature on entrepreneurial orientation, we captured a firm’s overall experimental orientation via their propensity to engage in risky innovative projects (Dess et al., 1997). This is similar to Bierly and Chakrabarti (1996), who differentiated between experimental vs. non experimental innovation in approved drugs. Firms in research have the option to develop drugs using elements of knowledge already implemented in prior innovation attempts by the firm. Two important elements of knowledge used in drug development are the mechanism of action and the origin of material, both of which are available from Pharmaprojects. We consider the origin of material, mechanism of action and indication as pockets of specialized knowledge which are embedded in a technology (Lane et al., 1998), and then examined if projects initiated by the firm in the last four years are based on knowledge were novel (experimental) to the firm.

We counted all compounds in development of each focal firm as reported by Pharmaprojects. For each drug in development within the year’s t-1 to t-4, we determined if the project was or was not experimental. For example, if a firm had 10 drugs reported in development during a three-year timeframe and 3 of them deployed either a new mechanism of action or origin of material to solve a given therapeutic problem, its level of Experimental Orientation would be 0.3. Higher values of this measure indicate a higher propensity to experiment with novel knowledge to the firm.

Financial slack: We proxied Financial slack by the current ratio of the firm in a given year, which is the ratio of its current assets divided by its current liabilities (Bourgeois III, 1981; partnership (almost like an arm’s length transaction) whose classification as a “partnership” may be questioned. Therefore, as we report in our robustness checks, we ran our models excluding all those extremely loosely coupled partnerships. Our results remained qualitatively the same.

Given the lag structure, we started our analysis in 1998 using partnership stock from 1994-1997.
Greve, 2003; Singh, 1986). Firms with a low current ratio are resource-constrained as they have less free financial resources at hand.

Managerial resources: The availability of managerial resources such as managerial attention is difficult to observe as, unlike financial resources, they are not found on a firm’s balance sheet. However, a good proxy for the availability of managerial resources (or the lack thereof) is the firm’s ongoing product development activities: all else being equal, the more products in development, the less managerial resources are available to other projects. This resonates with resource based perspective in which firm growth in a previous period limits the growth of firms in subsequent years (Penrose, 1959). We constructed a variable called pipeline growth, which captured how the pipeline has gown or declined from year t-2 to t-1. We argue that a growing pipeline signals scarce managerial resources as the in-sourcing firm has many alternative development paths to pursue. Conversely, a decline in the pipeline is a good proxy for the availability of more managerial resources. We reverse coded the variable Managerial Resources as pipeline decline to indicate the availability of managerial resources.

Controls

We first controlled for the effect of other in-sourcing activities. We controlled for the effect of Tightly Coupled Research Partnerships, defined as the number of research agreements in which a firm engaged in the last three years wherein parties mutually shared knowledge and other resources. These arrangements are captured in Recap through the addition of distinct agreement types: CoL (Collaboration Agreement) and JVs (joint ventures). We also added an indicator variable Acquisition to control for firms that engaged in a research-oriented acquisition.

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17 All results are robust when excluding joint ventures. We checked news articles associated with approximately 10% of all partnerships (available from Recap) it and found that the Recap classification was very much in line with the actual announcements.
in the prior year. Finally, we added *Exploitation* as the number of alliances formed to develop and commercialize existing compounds in the previous four years (these partnerships in-source “ready to use” compounds and are hence at a later stage of development).

Second, we controlled for various financial and performance measures that affect new product development. We included the variable return on assets (*RoA*), which captures the firm’s performance. Other financial controls included *Total Assets* as a proxy for the firm’s size and *R&D intensity* (R&D divided by Total Sales), which proxies the emphasis firms places on research in general. Finally, we captured internal research by adding the number of *Patents* (logged) a firm applied for in a given year as an important intermediate output for innovation, which is considered highly relevant to new product development (Murray, 2002).

*Empirical Specification*

All variables were lagged by one year; for example, we predicted new products in development in year t by the financial controls from year t-1. The variables spanning multiple years (e.g., loosely coupled partnerships and experimentation) include the years t-4 to t-1. Our dependent variable takes only positive integer values, so it is recommended to use a count model. The negative binomial model is appropriate as it relaxes the assumption of having a mean equal to the standard deviation. We reported both a fixed effect and random effect negative binomial model but the Hausman (1978) test indicated that a fixed effect model is more appropriate. The fixed effect model controls for time invariant unobserved firm heterogeneity. Given that firm fixed effects may not be robust in this estimation (Allison *et al.*, 2002), we also report a random effects model and a fixed-effects Poisson quasi maximum likelihood estimator, which is robust when using firm fixed effects (Cameron *et al.*, 2009).
RESULTS

Table 1 depicts the descriptive statistics and the bivariate correlation matrix. The summary statistics (e.g., Total Assets) indicated that our sample firms are large incumbent players in the industry (US$ 12 billion in assets on average). The firms were quite active with external partners with an average stock (based on four years) of 5.2 loosely coupled research partnerships. Table 1 shows that some correlations are high as for example loosely and tightly coupled partnerships are both correlated with firm size \((Total \ Assets)\).\(^{18}\)

Table 2 depicts the results for all hypotheses. Model 1 only shows the control variables. \textit{Tightly Coupled Partnerships} and \textit{Patents} are a strong predictor for new products in development. In Models 2 and 3, we added the stock of loosely coupled research partnerships. We only found a significant positive effect using a random effects model (Model 3) while in the fixed effects model (Model 2), the coefficient, while positive, does not reach acceptable statistical significance levels. Overall, these results provide only weak support for Hypothesis 1.

In Model 4, we added the first interaction: experimental orientation with loosely coupled partnerships. The results support Hypothesis 2. The interaction effect is best demonstrated graphically, which we show in Figure 1. At high levels (75\(^{th}\) percentile) of \textit{Experimental Orientation}, firms benefit much more from loosely coupled partnerships than at lower levels (25\(^{th}\) percentile).

\(^{18}\) Multicollinearity is not a concern. The mean VIF for the final models was below 2.4 and individual VIFs were below 4.6, all well below the recommended cut-off levels. We centered all variables before interacting them (Cohen \textit{et al.}, 2003). We further examined multicollinearity through the collin command in STATA. Neither tolerance nor conditioning index raised any concerns.
In Model 5, we entered the interaction of *Loosely Coupled Partnerships* and *Managerial Resources* (proxied by percentage decline in the number of drug development projects the firms has to attend to). As expected, the interaction was positive, indicating that the decline in the pipeline may free up managerial resources, thus allowing firms to benefit from *Loosely Coupled Partnerships*. The result is shown graphically in Figure 2 plotting *Managerial Resources* at 25th, 50th and 75th percentile.

[Insert Figure 2 about here]

Finally, Model 6 shows the interaction of loosely coupled partnerships and *Financial Slack* (current ratio). The results confirmed Hypothesis 4: the availability of financial resources allows firms to more effectively benefit from *Loosely Coupled Research Partnerships*. We demonstrate the effect graphically plotting *Financial Slack* at the 25th, 50th and 75th percentile.

[Insert Figure 3 about here]

To further examine the interaction effect, we report marginal effects in Table 4 and compare marginal effects when the values of the three moderators are at the 25th percentile, the median and at the 75th percentile\(^{19}\). Testing the difference among coefficients of the 25th and 75th percentile derived from STATA’s margins command, we found that the effect of loosely coupled partnerships is significantly stronger at higher levels of all moderators.

Model 7 shows the full model with all interactions, which remain supported and results are also similar in a random effects model in Model 8 and a fixed-effects Poisson quasi maximum likelihood model (Model 9). Overall, these results confirmed our contention that firm context in the form of experimental orientation, financial slack and managerial resources substantially positively affect a firm’s ability to convert loosely coupled research partnerships into innovations.

\(^{19}\) Very similar results are obtained by using mean and a standard deviation above the mean values.
Robustness Tests

We conducted several robustness tests (Table 5). We used an alternative measure for financial slack: working capital over sales (Bourgeois III, 1981; Singh, 1986) and found results similar to those reported for Hypothesis 3 (Model 11). We also deployed two alternative operationalizations for Managerial Resources. Namely, we used the number of Therapeutic Areas pursued by the in-sourcing firm to proxy a constraint on managerial resources (Model 12). Alternatively, we argue that the number of sourcing activities in which the in-sourcing firm is involved in year t-1 may also bind managerial resources (Model 13). As Models 12 and 13 indicate, our results show a sensitivity of loosely coupled partnerships to a lack of managerial resources. In order to demonstrate that the moderations are particularly important for loosely coupled partnerships, we ran the same analysis interacting Tightly Coupled Partnerships (Model 14) and found no significant effect except for Experimental Orientation, which is marginally significant. Finally, we examined whether our results would be robust if we excluded the most extreme cases of loosely coupled partnerships (i.e., pure licensing agreements). Our results were robust (Model 15).

Endogeneity

An important concern in our study is that the decision to engage in loosely coupled partnerships may be endogenous. To address this issue, we further examined the data to determine if some firms systematically do not engage in loosely coupled partnerships. In our sample, all firms engaged in at least 1 loosely coupled partnership between 1994 and 2006 (the
timeframe in which the independent variable is measured). Hence, there was no evidence that some firms avoid loosely coupled partnerships altogether. This said, in order to further address endogeneity concerns, we conducted the following robustness tests.

First, we limited our sample to firm years in which we observed a stock of loosely coupled partnerships (Model 10). This reduced our sample to 377 firm-year observations. We then replicated our analysis; the results found similar support compared to the full sample.

Second, we examined if the identified relationships hold only for specific types of firms. We split the sample by the size of firms and examined differences between larger and smaller incumbents in our sample. The results (available upon request) are very much in line with the results for the full sample (with the exception of H3 managerial resources for the smaller incumbents, which has the expected sign but is not significant). These robustness tests along with using firm fixed effects gave us increased confidence that our results were not driven by the selection of loosely coupled partnerships by specific types of firms.

[Insert Table 5 about here]

DISCUSSION

Understanding how future goods and services are discovered, developed and commercialized represents a fundamental question in strategy and innovation management research (Ahuja et al., 2001). Our study attempts to illuminate how firms manage this process when they opt to access external knowledge via loosely coupled partnerships. The study lies at the heart of two core organizational processes: interorganizational partnerships and new product development, both of which have a profound impact on a firm’s ability to build value-creating strategies.
We find that accessing external knowledge via loosely coupled partnerships matters for innovative performance, but the innovation benefits of such partnerships reach their full potential only in specific firm contexts. Namely, we identify the in-sourcing firm’s experimental orientation, its availability of financial slack and managerial resources as three key moderators that allow it to reap the innovation benefits of loosely coupled research partnerships.

Our study makes three main contributions. First, we highlight that scholars may need to distinguish between tightly and loosely coupled research partnerships when examining their effect on innovative performance in general. In the pharmaceutical space, previous studies (Hess et al., 2011; Nicholls-Nixon et al., 2003) have found surprisingly little evidence of a direct relationship between in-sourcing external knowledge through partnering and generating new product development candidates, which may stem from collapsing both tight and loose research partnerships into one single category\textsuperscript{20}.

Second, we reveal that although the effect of loosely coupled research partnerships on the in-sourcing firm’s innovative performance does not seem to be statistically strong, when we look at its interaction with the firm’s experimental orientation as well as with its availability of financial and managerial resources, the results are strong and robust to several different specifications. While extant research has tended to focus on the benefits of tightly coupled partnerships, we unveil in this paper the conditions under which another category of partnerships (i.e., loosely coupled) may provide a focal in-sourcing firm with significant innovation benefits. Previous studies have already suggested that loosely coupled partnerships may be ideal in settings of rapid environmental change as they allow firms to effectively exploit the division of labor and gain access to specialized knowledge. Our results, highlight that all these potential

\textsuperscript{20} For example Rothaermel and Hess (2011) find no direct effect from upstream (i.e. discovery) partnerships on new product development in a similar context.
advantages of loosely coupled partnerships are much more likely to be manifested in terms of innovation benefits in the presence of a strong experimental orientation, financial slack and managerial resources in the in-sourcing firm.

Finally, we also contribute to the literature on financial slack. While the direct effect of slack on innovation continues to be subject to debate (Nohria et al., 1996), our study reveals that financial slack may be an important contingency for firms to benefit from loosely coupled partnerships.

Overall, our paper demonstrates that loosely coupled partnerships can also be important vehicle to allow firms to devise solutions new to an industry. This should be an important reminder for managers and researchers alike that firms may achieve innovations through multiple paths and distinct external knowledge sourcing strategies.
Table 1: Correlation Table & Summary Statistics (n=454)

<table>
<thead>
<tr>
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<th>1</th>
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<tbody>
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<td>1 Innovative Performance</td>
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<tr>
<td>2 Exploitation</td>
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<td></td>
<td></td>
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<tr>
<td>3 Acquisition</td>
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<td>0.24</td>
<td>1.00</td>
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<td></td>
<td></td>
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<tr>
<td>4 R&amp;D Intensity</td>
<td>-0.11</td>
<td>-0.13</td>
<td>0.01</td>
<td>1.00</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>5 Tightly Coupled Partnerships</td>
<td>0.62</td>
<td>0.68</td>
<td>0.29</td>
<td>-0.03</td>
<td>1.00</td>
<td></td>
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<tr>
<td>6 Patents (log)</td>
<td>0.52</td>
<td>0.50</td>
<td>0.16</td>
<td>-0.20</td>
<td>0.46</td>
<td>1.00</td>
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<tr>
<td>7 RoA</td>
<td>0.31</td>
<td>0.26</td>
<td>0.08</td>
<td>-0.54</td>
<td>0.28</td>
<td>0.32</td>
<td>1.00</td>
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<tr>
<td>8 Total Assets (BNs)</td>
<td>0.63</td>
<td>0.58</td>
<td>0.26</td>
<td>-0.13</td>
<td>0.70</td>
<td>0.54</td>
<td>0.20</td>
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<tr>
<td>9 Managerial Resources</td>
<td>0.01</td>
<td>0.01</td>
<td>-0.17</td>
<td>-0.19</td>
<td>-0.05</td>
<td>-0.01</td>
<td>0.03</td>
<td>-0.04</td>
<td>1.00</td>
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<tr>
<td>10 Financial Slack</td>
<td>-0.34</td>
<td>-0.29</td>
<td>-0.16</td>
<td>0.38</td>
<td>-0.31</td>
<td>-0.36</td>
<td>-0.31</td>
<td>-0.35</td>
<td>-0.02</td>
<td>1.00</td>
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</tr>
<tr>
<td>11 Experimental Orientation</td>
<td>-0.25</td>
<td>-0.25</td>
<td>-0.10</td>
<td>0.11</td>
<td>-0.22</td>
<td>-0.20</td>
<td>-0.24</td>
<td>-0.27</td>
<td>-0.08</td>
<td>0.06</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>12 Loosely Coupled Partnerships</td>
<td>0.58</td>
<td>0.59</td>
<td>0.22</td>
<td>-0.06</td>
<td>0.65</td>
<td>0.51</td>
<td>0.31</td>
<td>0.59</td>
<td>0.03</td>
<td>-0.28</td>
<td>-0.24</td>
<td>1.00</td>
</tr>
</tbody>
</table>

|        | Mean   | 5.41  | 5.75  | 0.45  | 0.21  | 5.02  | 4.35  | 0.15  | 12.73 | 2.42  | 2.60  | 0.51  | 5.22  |
|        | Standard Deviation | 6.99  | 5.71  | 0.50  | 0.30  | 6.03  | 1.20  | 0.11  | 18.05 | 0.37  | 1.38  | 0.18  | 6.69  |
|        | Minimum Value       | 0     | 0     | 0.00  | 0.00  | 0.00  | -0.10 | 0.23  | 0.00  | 0.68  | 0.00  | 0     |       |
|        | Maximum Value       | 47    | 35    | 1.00  | 2.79  | 38.00 | 6.89  | 0.41  | 123.68| 3.00  | 6.12  | 1.00  | 34    |
Table 2: Regression Results - Dependent Variable: New products in development (innovative performance), FE-Neg Binomial

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Year and Firm Effects</td>
<td>b se</td>
<td>b se</td>
<td>b se</td>
<td>b se</td>
<td>b se</td>
<td>b se</td>
</tr>
<tr>
<td>Exploitation (4y)</td>
<td>-0.019* (0.009)</td>
<td>-0.019* (0.009)</td>
<td>-0.016+ (0.009)</td>
<td>-0.017+ (0.009)</td>
<td>-0.023+ (0.009)</td>
<td>-0.016+ (0.009)</td>
</tr>
<tr>
<td>Acquisition (t-1)</td>
<td>-0.023 (0.075)</td>
<td>-0.020 (0.074)</td>
<td>-0.015 (0.073)</td>
<td>0.003 (0.073)</td>
<td>-0.025 (0.073)</td>
<td>-0.037 (0.074)</td>
</tr>
<tr>
<td>R&amp;D Intensity (t-1)</td>
<td>-0.324 (0.261)</td>
<td>-0.327 (0.262)</td>
<td>-0.044 (0.228)</td>
<td>-0.329 (0.263)</td>
<td>-0.382 (0.262)</td>
<td>-0.274 (0.261)</td>
</tr>
<tr>
<td>Tightly Coupled Partnerships (4y)</td>
<td>0.034*** (0.009)</td>
<td>0.033*** (0.009)</td>
<td>0.037*** (0.009)</td>
<td>0.026** (0.009)</td>
<td>0.037*** (0.009)</td>
<td>0.030*** (0.009)</td>
</tr>
<tr>
<td>Patents (t-1)</td>
<td>0.171* (0.078)</td>
<td>0.169* (0.078)</td>
<td>0.318*** (0.060)</td>
<td>0.190* (0.078)</td>
<td>0.178* (0.078)</td>
<td>0.175* (0.077)</td>
</tr>
<tr>
<td>RoA (t-1)</td>
<td>0.215 (0.561)</td>
<td>0.181 (0.563)</td>
<td>0.486 (0.530)</td>
<td>0.163 (0.564)</td>
<td>0.115 (0.560)</td>
<td>0.226 (0.558)</td>
</tr>
<tr>
<td>Total Assets (t-1)</td>
<td>-0.799 (2.363)</td>
<td>-1.098 (2.405)</td>
<td>0.106 (2.243)</td>
<td>-0.272 (2.376)</td>
<td>-0.635 (2.319)</td>
<td>-1.033 (2.350)</td>
</tr>
<tr>
<td>Experimental Orientation (4y)</td>
<td>0.548+ (0.299)</td>
<td>0.594+ (0.303)</td>
<td>0.241 (0.290)</td>
<td>0.540+ (0.299)</td>
<td>0.585+ (0.301)</td>
<td>0.600+ (0.303)</td>
</tr>
<tr>
<td>Managerial Resources.</td>
<td>-0.019 (0.122)</td>
<td>-0.011 (0.123)</td>
<td>0.134 (0.120)</td>
<td>-0.011 (0.122)</td>
<td>-0.084 (0.115)</td>
<td>-0.011 (0.122)</td>
</tr>
<tr>
<td>Financial Slack (Current Ratio, t-1)</td>
<td>-0.091+ (0.047)</td>
<td>-0.089+ (0.047)</td>
<td>-0.096+ (0.043)</td>
<td>-0.084+ (0.047)</td>
<td>-0.082+ (0.047)</td>
<td>-0.075 (0.048)</td>
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<tr>
<td>Loosely Coupled Partnerships (4y)</td>
<td>0.007 (0.007)</td>
<td>0.014+ (0.006)</td>
<td>0.0200 (0.007)</td>
<td>0.007 (0.007)</td>
<td>0.012 (0.007)</td>
<td></td>
</tr>
<tr>
<td>Loosely Coupled X Experimental Orientation</td>
<td></td>
<td></td>
<td>0.126** (0.042)</td>
<td></td>
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</tr>
<tr>
<td>Loosely Coupled X Managerial Resources</td>
<td></td>
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<tr>
<td>Loosely Coupled X Financial Slack</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Constant</td>
<td>1.794*** (0.207)</td>
<td>1.770*** (0.207)</td>
<td>1.505*** (0.194)</td>
<td>1.773*** (0.207)</td>
<td>1.845*** (0.213)</td>
<td>1.786*** (0.206)</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>-823.58</td>
<td>-823.08</td>
<td>-1045.12</td>
<td>-818.65</td>
<td>-819.86</td>
<td>-819.77</td>
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<tr>
<td>N</td>
<td>454</td>
<td>454</td>
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</tbody>
</table>

+ p<.10, * p<.05, ** p<.01, *** p<.001
Table 3: Regression Results - Dependent Variable: New products in development

<table>
<thead>
<tr>
<th>Model</th>
<th>Year and Firm Effects</th>
<th>Exploitation (4y)</th>
<th>Acquisition (t-1)</th>
<th>R&amp;D Intensity (t-1)</th>
<th>Tightly Coupled Partnerships (4y)</th>
<th>Patents (t-1)</th>
<th>RoA (t-1)</th>
<th>Total Assets (t-1)</th>
<th>Experimental Orientation (4y)</th>
<th>Managerial Resources. (Pipeline Decline, (t-1))</th>
<th>Financial Slack (Current R., t-1)</th>
<th>Loosely Coupled Partnerships (4y)</th>
<th>Loosely Coupled X Experimental Orientation</th>
<th>Loosely Coupled X Managerial Resources</th>
<th>Loosely Coupled X Financial Slack</th>
<th>Constant</th>
<th>Log Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>M7: FE Full Model</td>
<td>b: -0.016+ (0.009)</td>
<td>se: 0.009</td>
<td>b: -0.020</td>
<td>se: 0.071</td>
<td>b: 0.028** (0.009)</td>
<td>b: 0.200**</td>
<td>b: 0.154</td>
<td>b: -0.060</td>
<td>b: 0.518+ (0.298)</td>
<td>b: -0.083 (0.115)</td>
<td>b: -0.064 (0.047)</td>
<td>b: 0.008</td>
<td>b: 0.125**</td>
<td>b: 0.032*</td>
<td>b: 0.022**</td>
<td>b: 1.869***</td>
<td>b: -812.38</td>
</tr>
<tr>
<td>M8: Random Effects Full Model</td>
<td>b: -0.011 (0.009)</td>
<td>se: 0.009</td>
<td>b: -0.017</td>
<td>se: 0.069</td>
<td>b: 0.029** (0.009)</td>
<td>b: 0.313***</td>
<td>b: 0.515</td>
<td>b: 1.851 -0.068</td>
<td>b: 0.151*** (0.037)</td>
<td>b: 0.018 (0.113)</td>
<td>b: -0.068 (0.042)</td>
<td>b: 0.013+</td>
<td>b: 0.151***</td>
<td>b: 0.031*</td>
<td>b: 0.023**</td>
<td>b: 1.658***</td>
<td>b: -1029.33</td>
</tr>
<tr>
<td>M9: Poisson FE (QML) Full Model</td>
<td>b: -0.017** (0.006)</td>
<td>se: 0.009</td>
<td>b: -0.052</td>
<td>se: 0.064</td>
<td>b: 0.028*** (0.006)</td>
<td>b: 0.179*</td>
<td>b: 0.650</td>
<td>b: 0.965</td>
<td>b: 0.086* (0.040)</td>
<td>b: -0.138 (0.113)</td>
<td>b: -0.017 (0.049)</td>
<td>b: 0.006</td>
<td>b: 0.086*</td>
<td>b: 0.036*</td>
<td>b: 0.021**</td>
<td>b: 0.021**</td>
<td>b: -858.50</td>
</tr>
<tr>
<td>M10: FE Loosely Coupled Stock &gt;0</td>
<td>b: -0.020* (0.009)</td>
<td>se: 0.009</td>
<td>b: -0.016</td>
<td>se: 0.074</td>
<td>b: 0.030** (0.009)</td>
<td>b: 0.168*</td>
<td>b: 0.382</td>
<td>b: 0.321</td>
<td>b: 0.724* (0.340)</td>
<td>b: 0.036 (0.141)</td>
<td>b: -0.046 (0.052)</td>
<td>b: 0.0200</td>
<td>b: 0.101*</td>
<td>b: 0.026+</td>
<td>b: 0.020*</td>
<td>b: 0.382</td>
<td>b: -705.51</td>
</tr>
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+ p<.10, * p<.05, ** p<.01, *** p<.001

Table 4: Effects of Loosely Coupled Partnerships at different levels of moderators y

<table>
<thead>
<tr>
<th>STATA - Margins</th>
<th>y=Experimental Orientation</th>
<th>y=Managerial Resources</th>
<th>y=Financial Slack</th>
</tr>
</thead>
<tbody>
<tr>
<td>When y is at the 25th percentile</td>
<td>0.008 (0.007)</td>
<td>0.005 (0.006)</td>
<td>0.007 (0.006)</td>
</tr>
<tr>
<td>When y is at the median</td>
<td>0.023** (0.008)</td>
<td>0.009 (0.006)</td>
<td>0.023* (0.009)</td>
</tr>
<tr>
<td>When y is at the 75th percentile</td>
<td>0.038** (0.011)</td>
<td>0.017* (0.007)</td>
<td>0.046** (0.017)</td>
</tr>
<tr>
<td>Changes in the marginal effect (from 25th to 75th percentile)</td>
<td>0.03** chi2= 9.05</td>
<td>0.12* chi2= 6.00</td>
<td>0.39** chi2= 6.94</td>
</tr>
</tbody>
</table>
Table 5: Robustness Tests - Dependent Variable: New products in development (innovative performance)

<table>
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<tbody>
<tr>
<td></td>
<td>b</td>
<td>se</td>
<td>b</td>
<td>se</td>
<td>b</td>
</tr>
<tr>
<td><strong>Year and Firm Effects</strong></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Exploitation (4y)</strong></td>
<td>-0.018*</td>
<td>(0.009)</td>
<td>-0.020*</td>
<td>(0.009)</td>
<td>-0.018*</td>
</tr>
<tr>
<td><strong>Tightly Coupled Partnerships (4y)</strong></td>
<td>0.032***</td>
<td>(0.009)</td>
<td>0.033***</td>
<td>(0.009)</td>
<td>0.032***</td>
</tr>
<tr>
<td><strong>Patents (t-1)</strong></td>
<td>0.145+</td>
<td>(0.079)</td>
<td>0.167*</td>
<td>(0.080)</td>
<td>0.166*</td>
</tr>
<tr>
<td><strong>Experimental Orientation (4y)</strong></td>
<td>0.539+</td>
<td>(0.302)</td>
<td>0.834**</td>
<td>(0.318)</td>
<td>0.649*</td>
</tr>
<tr>
<td><strong>Managerial Resources. (Pipeline Decline, t-1)</strong></td>
<td>-0.083</td>
<td>(0.122)</td>
<td>-0.004</td>
<td>(0.131)</td>
<td>0.052</td>
</tr>
<tr>
<td><strong>Financial Slack (Current Ratio, t-1)</strong></td>
<td>-0.076</td>
<td>(0.049)</td>
<td>-0.082+</td>
<td>(0.047)</td>
<td>-0.084+</td>
</tr>
<tr>
<td><strong>Loosely Coupled Partnerships (4y)</strong></td>
<td>0.008</td>
<td>(0.007)</td>
<td>0.047**</td>
<td>(0.018)</td>
<td>0.041**</td>
</tr>
<tr>
<td><strong>Financial Slack Alternative (WC/Sales, t-1)</strong></td>
<td>0.096</td>
<td>(0.080)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Loosely Coupled X F. Slack Alternative</strong></td>
<td>0.031*</td>
<td>(0.015)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Therapeutic Areas (t-1)</strong></td>
<td></td>
<td></td>
<td>0.033</td>
<td>(0.021)</td>
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</tr>
<tr>
<td><strong>Loosely Coupled X Therapeutic Areas</strong></td>
<td></td>
<td></td>
<td>-0.005*</td>
<td>(0.002)</td>
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<tr>
<td><strong>Alternative Modes (t-1)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.141+</td>
</tr>
<tr>
<td><strong>Loosely Coupled X Alternative Modes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.020**</td>
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<tr>
<td><strong>Tightly Coupled X Experimental Orientation</strong></td>
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<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td><strong>Tightly Coupled X Financial Slack</strong></td>
<td></td>
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</tr>
<tr>
<td><strong>Loosely Coupled (NPL) (4y)</strong></td>
<td></td>
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</tr>
<tr>
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</tr>
<tr>
<td><strong>Loosely Coupled (NPL) X Managerial Resources</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Loosely Coupled (NPL) X Financial Slack</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td>1.771***</td>
<td>(0.216)</td>
<td>1.652***</td>
<td>(0.239)</td>
<td>1.636***</td>
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<tr>
<td><strong>Log Likelihood</strong></td>
<td>-831.92</td>
<td>454</td>
<td>-763.39</td>
<td>454</td>
<td>-818.06</td>
</tr>
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+ p<.10, * p<.05, ** p<.01, *** p<.001, insignificant controls omitted
Figure 1 – Experimental Orientation Interaction

Figure 2 – Managerial Resources Interaction
Figure 3 – Financial Slack Interaction
BIBLIOGRAPHY


