



Paper to be presented at the

35th DRUID Celebration Conference 2013, Barcelona, Spain, June 17-19

## **Open innovation and governance: Innovation partnerships between industry and university in science-based sectors**

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### **Abstract**

This article connects emerging industry-university contractual practice to theory, learning from what has happened in practice to develop a theoretical explanation of the governance of partnerships in an open innovation context. The article contributes to the literature on open innovation by addressing two issues largely neglected by existing literature. First, it deals with the governance of the creation of innovation in an open innovation context. Most of the literature on open innovation is concerned with the search for external sources of innovation (that is, the identification of external partners which have already developed an innovation and access to this innovation) rather than the generation of innovation in an open innovation context (including the governance mechanisms associated with this). Second, we focus on open innovation in science-based sectors, which face prolonged periods of risky investment in research and uncertain outcomes. The empirical focus of the article is partnerships between large companies and universities, a domain in which both issues are prominent. The article examines the relationship between open innovation and governance, showing that incomplete contracting challenges are pervasive within industry-university partnerships and demonstrating that different types of industry-university partnerships necessitate the creation of varying governance arrangements, in terms of the formal and informal contractual mechanisms used to manage the partnerships. Three main types of partnerships are derived: rights-oriented, tapping-in and contracting for innovation partnerships. Each type of partnership creates unique governance challenges.

**Open innovation and governance:  
Innovation partnerships between industry and university in science-based sectors**

**Introduction**

Over the past 25 years large pharmaceutical companies have been engaging in multi-year partnerships with universities, designed with the goal of accessing research by leading academic scientists. Some of these partnerships are explicitly motivated by open innovation, developed as part of a broader strategy by pharmaceutical companies to open firm boundaries to access external sources of knowledge and technology (Chesbrough, 2003; Hunter and Stephens, 2010). Many of these partnerships, however, have failed to produce important patentable innovations for pharmaceutical firms. The article has two aims. Firstly, we examine the relationship between open innovation and governance, showing that incomplete contracting challenges are pervasive within industry-university partnerships. Secondly, we show how different types of industry-university partnerships necessitate the creation of varying governance arrangements, in terms of the formal and informal contractual mechanisms used to manage partnerships.

The practices of industry participants have forged ahead of innovation theory. Little is known about the details of how actors engaged in open innovation govern their relationship through contracts. Open innovation research has focused on the patterns and benefits of collaboration for innovation but has paid little attention to governance issues, including those to mitigate incomplete contracting problems. An emerging literature focused on 'contracting for innovation' (Gilson et. al., 2010) can help understand the governance structure of highly collaborative inter-organizational relations. We build a theoretical bridge between the open innovation research and the legal literature on complex contracts, emphasizing the interplay between contractual structures and technical relations in supporting open innovation. This article connects emerging industry-university contractual practice to theory, learning from what has happened in the real world to develop a theoretical explanation of the governance of partnerships in an open innovation context.

The article contributes to the literature on open innovation by addressing two issues largely neglected by existing literature. First, it deals with the governance of the creation of innovation in an open innovation context. Most of the literature on open innovation is concerned with the search for external sources of innovation (that is, the identification of external partners which have already developed an innovation and access to this innovation) rather than the generation of innovation in an open innovation context (including the governance mechanisms connected to this) (West and Bogers, 2011). The limited attention to governance issues in the literature refers to how to acquire an existing innovation from an external source, rather than the governance (and incentives) for complex inter-organizational collaboration to create or develop innovation.

Second, we focus on open innovation in science-based sectors. Science-based sectors face prolonged periods of risky investment in research and uncertain outcomes. We focus here on the increasingly important open innovation relations between firms and universities to develop collaborative science projects. This requires attention to complex governance matters that are not present (or are less significant) in the most prevalent types of open innovation involving external technology sourcing.

This paper is organized as follows. The next section discusses the existing literature on open innovation and contracting, pointing out limits to both approaches in explaining complex inter-organizational innovation relationships. We describe the method briefly and then turn to an analysis of the different

types of innovation partnerships between pharmaceutical firms and university and their governance. We then discuss the findings and conclude the analysis.

### **Open innovation and governance**

The production of knowledge required to initiate and develop innovation relies increasingly less on the importance of large centralized labs in industries such as pharmaceuticals and telecommunications (Mowery, 2009). Globalization, increased scientific and technological complexity, and information and communication technologies are driving firms to shift from a 'closed' model of innovation, to an 'open' innovation model, with firms opening up their boundaries to access external sources of knowledge and technology and bringing innovations developed in-house to market through external organizations (Baldwin and von Hippel, 2011; Chesbrough, 2003; 2006). Open innovation can involve exchange of knowledge and collaboration for innovation with a diversity of external sources (competitors, suppliers, users, or universities) (Laursen and Salter, 2006).

Open innovation is influencing the industrial organization of the pharmaceutical industry, which has been a major initiator of partnerships with university science departments (Kenney, 1988). During the 1970s and 1980s, pharmaceutical companies were vertically integrated firms, and only gradually began to open their research programs to external collaborations during the late 1990s (see Henderson et. al, 1999; Pisano, 2006; Powell et al., 1996). A paradigm change for the pharmaceutical industry, biotechnology, combined with information technology, offered a new way of searching for new products, reducing reliance on random synthesis and mass screening, automating and speeding up the research process, reducing time to market and also making the search process more rational, developing new processes and products. In this new context, universities (and also biotechnology firms) offered pharmaceutical firms a 'window on the science' and the possibility of taking advantage of patentable innovations for which they had carried out early research.

The decline of R&D productivity in the pharmaceutical industry in the past two decades, with increasing concentration of R&D investments in areas with high risk of failure, and high number of patent expiries, are motivating pharmaceutical firms to move away from highly integrated research practices towards a more open, collaborative approach to research and development, characteristic of open innovation (Munos, 2009; Pammoli et al., 2011). An important demonstration effect has been provided by the biotechnology industry, which in the late 1990s began to surpass the pharmaceutical industry in research productivity. During the late 1990s through mid 2000s, biotechnology firms discovered nearly twice as many new drugs than the pharmaceutical industry with about half as much money invested in research and development, relying on less vertically integrated forms of organization that draw strongly on links with universities to achieve an innovative edge (Lawrence, 2006). Through negotiating multi-year research partnerships with university research departments, pharmaceutical companies are attempting to realize similar increases in R&D productivity that have been found in the biotechnology sector.

Open innovation helps explain when collaboration or contracting for technology and R&D can improve the innovative performance of firms. Open innovation can encompass different types of processes - inbound processes, including sourcing and acquiring, and outbound processes, including revealing and selling (Dahlander and Gann, 2010). Much of the literature focuses on inbound open innovation, and tends to focus on the processes of obtaining innovations, and less on their integration and commercialization (West and Gallagher, 2006; West and Bogers, 2011). A key finding is that the success of open innovation depends on in-house R&D, as, in order to assimilate and co-develop ideas that originate from external sources, firms need competencies in areas related to their partners' (Cohen and

Levinthal, 1990; Granstrand et al., 1997; Mowery et al., 1996). Factors that influence the use of external sources of innovation include strong appropriability regimes and high technology intensity (Chesbrough and Crowther, 2006; Huizingh, 2011), both found within the pharmaceutical industry. However, there is still little knowledge of organizational processes and structures enabling or hindering the adoption and success of open innovation, the factors that affect the impact of openness on performance, and the theoretical mechanisms behind these (Araujo Burcharth et al., 2012). In particular, there is limited attention in the literature on open innovation to the governance of the creation of innovation. Because the literature tends to focus on how to acquire an existing innovation from an external source, contractual issues are often of a short-term, transactional nature and are thus not seen as a major impediment to the performance of open innovation strategies (see Hagedoorn and Ridder, 2012).

Research on industry-university partnerships framed within the context of open innovation has only recently begun to emerge (see Perkman and Walsh, 2007). Fey and Birkinshaw (2005), however, have helped explain the widespread emergence of industry-university collaborations in recent years. In a study comparing the use of external contracting and partnering, they conclude that external contracting with other firms has a negative impact on R&D performance, whereas partnering with universities has a positive impact. They argue that partnering with universities can result in high levels of inflow and outflow of knowledge, and that both organizations can expect to develop an understanding of each others' capabilities and technologies. Mutual learning will depend on the absorptive capacity of the parties and the relationship-specific investment they make (Cohen and Levinthal, 1990; Hamel, 1991; Lane and Lubatkin, 1998). The argument made by these contributions is that, for firms, partnering with universities, as opposed to with competitors, has the benefit that universities tend to be more open and the outflow of knowledge from the firm is less sensitive, as universities are not potential competitors. But openness to new ideas from university also requires the development of firm capabilities to recognize the insights from universities and make use of these. It is interesting to note that, in some analyses, relationships with universities are shown to be themselves instrumental in nurturing firms' absorptive capacity (Bishop et al., 2011).

Organizational challenges have been identified as a key theme in the management of open innovation partnerships of firms with universities (Perkman and Walsh, 2007). Given the 'open science' orientation of most university research, establishing partnerships with academic laboratories would be seemingly less complex for firms that have embraced a strategy of externalizing some R&D activities. Nevertheless, scientists within firms and universities have different priorities and are situated within organizations with different structures and goals, creating governance challenges, particularly within complex longer-term industry-university partnerships. The emphasis on governance of open innovation collaborations involving universities is synergistic with broader research examining factors linked with successful knowledge acquisition from universities (Meyer-Krahmer and Schmoch, 1998; Arundel and Geuna, 2004). A key theme from this research is the conflict of orientation between the financial goals of firms and the traditional 'open science' orientation of universities (Merton, 1942), a problem that may be lessened by the increased importance of commercialization within most universities in recent years (Mowery et al., 2004). Bruneel et al. (2010) have argued that a firm's experience with inter-organizational collaboration makes it easier to overcome these 'orientation' problems but not those 'transaction-related' problems, including the tendency of industrial liaison offices to oversell research, conflicts regarding royalty payments from patents, and concerns about university rules (Thursby and Thursby, 2007).

The goal of many partnerships between firms and universities is to spur the creation of new science from which financial returns can be captured. This differs from the dominant emphasis within the open

innovation literature, on searching for, acquiring, and integrating existing technologies. Due to the longer-term and frequently collaborative nature of university-industry partnerships, governance issues are likely to focus on the nature of incentives necessary for complex inter-organizational collaboration to create or develop innovation. While the governance of collaborations has been flagged as an issue affecting the performance of industry-university partnerships, this literature is in an early stage of development, focused primarily on issue identification. Hagedoorn and Hesen (2007) find that contracts for different forms of inter-firm innovation partnerships have similar types of clauses, including adaptation, damage, warranties, property rights and dispute settlement mechanisms but that they are given a different content and have different effects in different types of partnerships. Some contributions have addressed risks, uncertainty and governance choice (van de Vrande et al., 2006), but little is known about the details of how organizations engaged in open innovation govern their relationship for innovation development through contracts. Indeed, risks vary across different types of open innovation processes, but can include costs of coordination across different organizations, with difficulties to bridge organizational boundaries, problems of appropriation of benefits, costs of competition from the risk that one organization would act opportunistically in bad faith, leaking of valuable competitive information, and difficulty of maintaining a large number of partnerships (see review by Dahlander and Gann, 2010). In a similar vein, Munsch (2009) argues that a number of issues need to be addressed in the governance of the open innovation process: ownership rights, fields of use, exclusivity, resource commitments and potential timing, intellectual property, termination conditions and rights. He argues that partners need to define in advance how new intellectual property that is created by their joint work will be owned and legal rights maintained as knowledge is exchanged as part of the collaborative innovation process (see also Luoma et al., 2010; Graham and Mowery, 2006; West, 2006; Gallini, 2002).

The litany of potential governance issues created by open innovation collaborations leads to the conclusion that contracts will be developed to manage at least some aspects of collaborations. An exploratory study by Hagedoorn and Ridder (2012) suggests that firms active in open innovation have a strong preference for the governance of their open innovation relation through formal contracts, and that contracts may be used to either control the collaboration with open innovation partners (legal perspective on contracts) or to monitor the progress of collaboration (a more practical perspective), or both. Developing contracts to govern inter-organizational innovation partnerships, however, is very challenging as the specification of product characteristics cannot be contracted for in advance, but rather, result from collaboration, and it is difficult to agree beforehand the sharing of profits and costs and the results of cooperation, as such, therefore, contracts in this context are highly incomplete (Lee, 2009). Indeed, a requirement of a 'complete' contract is that parties are able to contemplate all possible contingencies, able to define and measure performance and that the contract must be enforceable. A complete contract stipulates what each party should do for every possible contingency and it is also a condition that no party should exploit another party's weakness. Nevertheless, partnerships for open innovation in science-based firms involve highly incomplete contracts given the scientific complexity and uncertainty, leading to great difficulties in specifying or measuring (contract) performance.

We share the broad concern with these authors on the importance of addressing governance within highly collaborative inter-organizational research partnerships. Also, we suggest that more complex governance issues will arise in open innovation relations between firms and universities to develop collaborative science projects (which might not be present or might be less significant in the most prevalent external technology sourcing relations). These projects are more distant from the market (in contrast to more applied or core technology development), are longer term, and have a high degree of uncertainty (regarding the scientific outcome as well as commercial outcome), but have the potential for

broad applicability and high profits (Cassiman et al., 2010; Hauser 1998). The following section suggests that recent contributions attempting to link formal and relational contracting and intensive technical collaboration provides a framework that can help explain the recent evolution of governance arrangements within industry-university partnerships.

### **Contracts and innovation**

Many industry-university partnerships are long-term contractual agreements involving investments in relationship-specific investments, domain areas well-explored within the law and economics and institutional economics traditions (Coase, 1937; Williamson, 1985; Milgrom and Roberts, 1992). Through arguing that contracting issues determine the boundaries of the firm, this tradition is in sharp contrast to most research on processes of open innovation, which argues that technical collaboration to achieve innovations within fast moving industries is an important determinant of the form of industrial organization adopted. We must note, however, that the patterns of industrial organization favored by open innovation scholars – highly collaborative relationships involving investments specific to the relationship – are the types of inter-organizational collaborations which institutional economists would predict are most likely to succumb to governance problems caused by the inability to write complete contracts. Law and economics scholars have long argued, for example, that investment in relationship-specific assets can be undermined by the threat of opportunism once the specific investments are made (see, e.g., Goldberg, 1985 and, more generally, Williamson, 1975). Similarly, within the context of highly complex fields, information asymmetries make it difficult to monitor the activities of partners (are they investing resources on partnership-specific activities, or applying ideas gleaned from a partnership to more lucrative opportunities elsewhere?), creating agency problems (see Miller, 1992).

Research within the broad institutional economics field has emphasized two distinct approaches to resolving incomplete contracting dilemmas. One approach, commonly seen within the law and economics tradition, focuses on the importance of legally enforceable contracts and advocates the creation of more sophisticated legal arrangements, such as price escalator devices within long-term supplier contracts (see Schwartz, 1992 and Easterbrook and Fischel, 1991). While important, the contracting perspective has been weakened by the findings of formal theorists that many so-called repeated games have no fixed or stable equilibrium solution and can produce any number of outcomes depending on the pattern of strategic interaction between players that develops within the context of a particular relationship (see Miller, 1992). In other words, designing a perfectly enforceable contract is, within complex forms of economic organization, often impossible.

A second approach emphasizes relational governance, pointing to social norms created within the context of long-term relations as the key to resolve incomplete contracting problems (MacNeil, 1978). The relational contracting view has been buoyed by empirical studies showing that social norms rather than explicit legal provisions frequently structure economic behavior between parties (see Lamoreaux et al., 2003; Ellickson, 1991). Within complex, long-term relationships, parties can develop social strategies to achieve cooperation, often resulting in the creation of credible commitments not to behave opportunistically (Kreps, 1990; Miller, 1992). Examples include the creation of a reputation not to exploit weaker parties (Gans and Stern, 2003) or ‘signaling’ strategies, such as making contingent investments in relationship-specific assets with the expectation that one’s contracting partner will reciprocate, allowing norms of cooperation to ensue (Axelrod, 1984).

While institutional economists have emphasized behavioral norms as the solution to incomplete contracting, law and politics scholars have emphasized the importance of technical cooperation in creating relational contracting norms. Described by Sabel (1993) as ‘learning by monitoring’, parties

may structure processes of technical collaboration in ways that generate the social or relational contracting norms needed to collaborate successfully. The idea that intense technical collaboration can provide monitoring and trust-generating opportunities is an important insight, one that creates a potential analytic bridge between the technical process-oriented open innovation literature and the contracting approach. However, the relational contracting perspective has a tendency of ignoring the importance of formal legal elements of contracting. Parties, even those with reputations as trustworthy, continue to rely on legally enforceable contracts to structure long-term relationships, at least in part (Gilson et al., 2009), and frequently resort to the 'shadow of the law' even when settling disputes informally (Mnookin and Kornhauser, 1979).

An emerging literature on 'contracting for innovation' acknowledges that incomplete contracting dilemmas can undermine relationships, but then views the evolution of cooperation between parties as a constructivist or interactive process in which firms combine relational and legal contractual elements. In coining the term 'contracting for innovation', Gilson et al. (2009; 2010) emphasize an interweaving or 'braiding' of legally enforceable contracts and informal or relational practices to support collaboration. They show how particular contracts for innovation create a process for the regular and mutual exchange of information about each party's competences and willingness to collaborate, binding them to imprecisely defined common projects through increased switching costs. Formal contracts support relational elements that "police the parties' expectations of capability, cooperation, and trust" (Gilson et al. 2009, p. 472), and "address, in turn, the substantive elements of the parties' performance" (p. 473).

The approach explicitly recognizes the importance of a commitment by parties to technical collaboration to both generate innovations and create relational contracting norms, but suggests that contracts be used to establish legally enforceable commitments needed to help parties commit to relationships in an uncertain environment. As argued by Gilson et al. (2010) "because parties can not specify ex ante the nature of the product to be produced or its performance characteristics, an informal contract will cover the terms of substantive performance; however, those performance terms will be developed through the very governance process that the formal elements of the contracts create" (p. 1383). Instead of specifying objectives, the idea is to create transparency and exchange of information. The expectation is that the formal terms induce informal behaviour that makes performance more easily observable and raises the level of trust (not simply eliciting reciprocity, but raising the confidence in the ability of the other party to perform as required by the agreement) (Gilson et al. 2010): "parties...treat trust as endogenous, as an object of contracting rather than as a precondition. They write contracts in which they manifestly intend to establish a deeply collaborative relation, where little or none existed before, through a combination of formal and informal elements" (p. 1404).

The contracting for innovation approach is a promising perspective with which to integrate the theoretical concerns of the open innovation and incomplete contracting literatures. Of particular interest is the idea that technical collaboration can generate relational contracting norms and facilitate monitoring, but with a back-stop provided by a legal framework specifying the broad goals, obligations, and incentive structures of parties to cooperate within a partnership. We will see that the technical organization and governance in recent industry-university partnerships have elements mirroring the contracting for innovation approach.

### **Research design and methods**

The research objective was to examine the relationship between open innovation and governance, showing that incomplete contracting challenges are pervasive within industry-university partnerships. Also, we sought to show how different types of industry-university partnerships necessitate the creation

of varying governance arrangements, in terms of the formal and informal contractual mechanisms used to manage partnerships. To yield more generalizable and robust insights (Eisenhardt and Graebner 2007), we built a varied sample of partnerships. Based on our literature review, we selected partnerships that presented ostensible variation in governance arrangements. First, we included cases with formal contracts that use upfront funding as a formal mechanism to achieve the goals of open innovation and cases that use performance-based mechanisms (such as biotechnology-type agreements) and technical collaboration to achieve their goals. Second, we included cases that involved co-location of industry labs next to universities and cases that did not because, following the discussion above, it is likely that co-location can facilitate relational contracting. We have studied partnerships in California and, in particular, studied a series of multi-year partnerships between 1982 and 2007 involving the Scripps Research Institute, a large biomedical research institution located in San Diego. Eight partnerships were analyzed (Table 1).

**Table 1: Rationale for selection of cases**

		<b>Type of formal contract</b>	
		<b>Upfront funding</b>	<b>Performance-based (biotech-type milestones)</b>
<b>Co-location</b>	<b>Yes</b>	Sandoz/Novartis-Scripps	Pfizer-UCSF Merck-Scripps
	<b>No</b>	PPG-Scripps J&J-Scripps Sandoz-Scripps Novartis-UC Berkeley Pfizer-Scripps	Not observed

Case studies were compiled from interviews (see Table 2) and secondary material. We interviewed alliance managers, both from industry and university. Most interviews were with individuals that had direct experience in the management of a particular partnership, though we were also able to interview senior managers from the pharmaceutical firms Pfizer and GlaxoSmithKline who were responsible for their firm’s overall university partnership strategy. We carried out 12 interviews with key informants. These interviews were semi-structured and lasted between 60 and 90 minutes. We also consulted press articles, books, and other documentation to develop an understanding of the contractual and relational practices used to govern the relationship, and obtain evidence surrounding the performance of the partnerships. Our analysis of the Novartis-UC Berkeley draws primarily on a detailed program review commissioned by UC Berkeley after completion of the partnership (Busch, 2004). To gather supplemental data on the performance of the partnerships, we also collected bibliometric data on joint publications arising from the partnerships (data on co-authored and multiple-address publications gathered from ISI Web of Knowledge) and data from the United States Patents and Trademarks Office (USPTO) on co-assigned patents to industry and university during and after the duration of the partnership.

**Table 2: List of interviewees by role, affiliation, and partnership discussed**

Alliance Manager, University of California, San Francisco (Pfizer-UCSF partnership)
Former Alliance Manager, PPG Industries (PPG-Scripps Partnership)
Alliance manager, The Scripps Research Institute (Merck-Scripps Partnership)
Senior Manager, Genomics Institute of the Novartis Research Foundation (Novartis-Scripps partnership)
Alliance Manager, Genomics Institute of the Novartis Research Foundation (Sandoz/Novartis-Scripps



partnership)

Former Alliance Manager, The Scripps Research Institute (PPG-Scripps Industries partnership)

Former Alliance Manager, The Scripps Research Institute (J&J-Scripps partnership)

Former Alliance Manager, The Scripps Research Institute (Sandoz/Novartis-Scripps partnership)

VP, Business Unit Director, Pfizer (drug discovery partnerships with universities)

Director, Business Development, Pfizer (drug discovery partnerships with universities )

VP, External Relations, GlaxoSmithKline (drug discovery partnerships with universities)

Senior Manager, Academic Partnerships, GlaxoSmithKline (drug discovery partnerships with universities)

The objective was to develop new theory (Eisenhardt, 1989). As in this case practice has forged ahead of theory, there is a need to understand this emerging, contemporary phenomena and explain the complex causal links in the real-world context this phenomena is nested within (Eisenhardt and Graebner, 2007). As we iterated between data and emerging logic, we gradually built a clearer characterization of the relevant dimensions of the governance of collaborative research partnerships between industry and university. The analysis revealed the key role of four dimensions of governance:

1. whether there is co-location or not;
2. the type of funding provided by pharmaceutical firms (as we will see below, this includes upfront funding, unrestricted/restricted money components, in-kind contribution, and biotechnology-type milestone based funding);
3. the type of agreement on intellectual property (reach-through intellectual property for industry, joint inventorship, and to be negotiated); and
4. the types of contracting (formal contract, including strong and light legal framework, relational governance mechanisms, ‘braiding’ of legal and relational elements).

We sought to understand the goals of industry and university in open innovation partnerships and the governance mechanisms developed. These elements are likely to generate incomplete contracting challenges. The incentives created through the contractual arrangements combined with relational governance, and also facilitated by co-location, will have an impact on the performance of the open innovation partnership. Indeed, the constellations of elements described above produce incentives for different patterns of behaviour that will have an effect on performance. Performance criteria differ among partnerships depending on the goals. For example, intellectual property (IP) reach-through agreements will focus on access for companies to IP developed at the partner university while in other partnerships the focus will be on collaborations designed to advance drug candidates in the clinical trials. While the overarching aim of the article was to demonstrate the importance of governance in open innovation, we are able to provide some evidence on performance in the cases where partnerships were completed.

### **Analysis of innovation partnerships of pharmaceutical firms with university**

Companies and universities are experimenting with a broad spectrum of ‘open innovation’ strategies. An analysis of the different partnerships of pharmaceutical firms with university reveals three different types of partnerships with distinctive governance arrangements. We call these ‘rights-oriented’, ‘tapping-in’ and ‘contracting for innovation’ partnerships respectively, and we describe these below.

#### *1. ‘Rights-oriented’ partnerships emphasizing formal contracts*

Many partnerships emphasized multi-year funding agreements in exchange for ‘reach-through’ rights on designated areas of intellectual property developed at the university partner, in addition to the provision of funds dedicated to collaborative research between industry and university scientists. In forming these partnerships, companies wanted a “window on science”, especially the new molecular

biology that, with the success of Genentech and other biotechnology firms, was seen as creating a new paradigm of basic research leading to drug discovery (Hall, 1992). Our interviewees suggested that these partnerships were seen as a way to solve the “not invented here” problem of many established firms, especially conglomerate chemical firms, with expertise focused on chemistry, and uncertain about the turn to biology. Companies also wanted access to discoveries made at leading biomedical research institutions (what some of our interviewees referred to as “harvesting” IP). This led companies to develop multi-year contracts involving upfront funding from universities in exchange to access to IP.

Prominent examples of this type of partnerships with California-based universities include:

- a ten-year agreement launched in 1982 between Johnson and Johnson (J&J) with the Scripps Research Institute totaling \$140 million and focused on biomedical technologies, renewed in 1992 for an additional five years and \$70 million in funding;
- a \$120 million, 15-year agreement beginning in 1985 between Pittsburgh Paint and Glass Industries (PPG) and Scripps to develop high-tech agricultural chemicals (herbicide drug design);
- a ten-year agreement in 1997 between Sandoz and Scripps for \$200 million;
- a \$25 million five-year agreement launched in 1997 between Novartis and the University of California, Berkeley (UC Berkeley) Department of Plant and Microbial Biology surrounding genomics research; and
- a five-year, \$100 million partnership initiated in 2007 between Pfizer and the Scripps Research Institute.

Within rights-oriented partnerships, funding from industry had two components. First, industry contributed what is called “unrestricted” funding to universities. The partner university would accept such funding and, in return, offer “reach through” access to IP developed at the partner university (or first right of refusal) surrounding research funded through the program over the course of the agreement, typically several years (see also Culliton, 1982a, 1982b; Kenney, 1988). For example, the J&J agreement with Scripps stipulated that Scripps would receive \$10 million in unrestricted funding per year over the duration of the contract. Second, rights-oriented partnerships also frequently contained tranches of “restricted” funding that was to be used to fund collaborative projects between industry and university scientists. The J&J partnership targeted \$4 million per year for joint research projects with Scripps scientists. This “restricted” component of funding, which scientists of university could obtain through writing proposals, allowed scientists from university and industry to work on projects that were more close to the pipeline of industry. Multi-year formal partnerships also typically included downstream royalties should products be commercialized from university technology.

As universities have a broad interest in seeing basic research being translated into societal benefit, multi-year funding partnerships are an attractive mechanism by which discoveries could flow into commercialization pipelines. However, universities are also extremely interested in locating sources of so-called “unrestricted” research funding, as such money could be used to enhance the competitiveness of research activities, such as augmenting salaries or buying state-of-the-art research equipment. This is very difficult to obtain on fragmented funding from the National Institute of Health to different projects to academic principal investigators, and therefore, became, in the words of one of the interviewees, “very addictive” for universities. The Scripps partnership with PPG led to a 40,000-square-foot addition to the Scripps molecular biology building and led to the employment of an additional 100 scientists and support staff within the organization.

Short 30-60 day time review periods combined with the organization of large pharmaceutical firms created a challenging environment to implement IP reach-through agreements. There was a consensus

among our interviewees that industry is frequently not in a position to put the greater bulk of the science developed in the course of the partnership to meaningful use. One of our interviewees described these partnerships as “trying to drink from a fire hose”. There are two reasons for this. First, pharmaceutical partners had to locate quickly specific individuals within large R&D hierarchies that had the scientific expertise to assess the potential of invention disclosures. Pharmaceutical firms frequently ran out of time or, once more alluding to the “not invented here” syndrome, found that internal scientists were hostile to in-licensing external technology, especially if doing so meant abandoning internal projects. Second, particularly with discoveries from the biological sciences, it was mentioned by multiple interview participants that it is difficult to judge the potential of the science at an early stage, with the consequence that industry would overlook science with important potential for commercialization.

Poorly designed governance arrangements help explain the weak performance of most university-industry partnerships characterized by the upfront funding model. Multi-year agreements between firms and universities involving upfront payments are incomplete contracts plagued by agency problems derived from both time-inconsistency and adverse selection. University faculty, and particularly those with an entrepreneurial orientation, have strong incentives to retain IP rights pertaining to their discoveries out of partnerships. Beginning in the early 1980s as a consequence of the passage of the Bayh-Dole Act, most major universities in the USA developed policies that provided financial compensation to professors that became involved in the commercialization of university research (Mowery et. al., 2004). Under the terms of most rights-oriented university partnerships with the pharmaceutical industry, the company received full control of IP secured by the reach-through deal or created through projects they funded in return for fixed royalties flowing to the university should a product drawing on a university technology reach the market (but with the long clinical trials of medicines the commercialization processes can draw out 10-15 years). Under normal university licensing rules, the inventing professor(s) would obtain a share of these royalties, typically a third. On the other hand, if the university controls ownership of the IP, the professor retains freedom of action and may continue to develop the technology, often increasing its licensing value when doing so. A particularly lucrative option is for the professor to launch a start-up firm, which usually results in both the university and professor obtaining an equity stake in a company.

Universities need to “service” partnerships that include IP reach-through rights. Under the rules of each of the long-term rights oriented partnerships studied, funding flowed to the university in yearly increments, allowing the pharmaceutical industry partner to terminate a deal if they could demonstrate bad faith from the university, for example, in not disclosing inventions to the company. That being said, each time the partner pharmaceutical company declined to pick up an option to in-license an invention that was then licensed to a third party the university essentially was paid twice – once by the long-term partner for the right of first refusal, and second by the eventual third party licensee (which would include spin-off companies).

Universities and their faculty can exploit the organizational and technical challenges facing pharmaceutical firms in evaluating university discoveries to retain ownership of technologies that faculty members or licensing office staff consider particularly valuable. A strategy to do so that was mentioned by multiple interview respondents was to disclose inventions at a very early stage in their scientific development (often at the stage of the initial grant proposal), when the ultimate commercial value was still largely unclear. During the interviews, it was noted that social capital developed between university and industry alliance managers was at times used to help university faculty preserve freedom

of action on a research area; in such cases the alliance manager could mention that a professor was interested in obtaining commercial rights for a technology and request an expedited review.

Evidence suggests that many entrepreneurial faculty members were able to preserve freedom of action over their inventions. Faculty at Scripps were founders on at least 50 start-up companies during the 1985-2012 period covered by various rights agreements with pharmaceutical firms (San Diego Business Journal, 2012; see also CHI, 2004). Evidence on the number of technologies in-licensed and eventually commercialized by reach-through agreements is limited. However, both the published evidence that does exist and comments from several interview participants suggests that pharmaceutical firms frequently have poor results with this partnership model. The Novartis-UC Berkeley partnership ended without a single technology funded through the program being licensed by Novartis (Busch et al., 2004), and interview evidence suggests that the Scripps partnerships with Pfizer and PPG also ended with few technologies being licensed. The only rights partnership that may be considered successful is the J&J partnership with Scripps. Over the 15 years of this partnership J&J in-licensed 95 inventions from Scripps, though many were returned to Scripps after an initial evaluation (House Committee, 1994). Four products went into later stages of commercialization (e.g. clinical trials) and three products (two diagnostic products and a pulmonary drug) were eventually marketed (Pink Sheet, 1992). One reason J&J may have been more successful in exploiting its IP reach through partnership is that the company created a subsidiary organization dedicated towards the evaluation and commercialization of technology derived from the Scripps partnership. Of the California-based rights partnerships reviewed, J&J is the only firm to have taken this step. While this subsidiary was not co-located with Scripps in La Jolla, creating a purpose-built organization may have helped J&J avoid organizational issues challenging other partnership sponsors.

Sponsored research collaborations initiated within rights-oriented partnerships also face governance challenges. Professors receiving funding from industry partnerships receive, in a sense, 'easy' research funding as it is awarded through an internal mechanism rather than competitive federal research grant applications. But they receive weak financial incentives for participating, as commercialization rights are owned by the sponsor company and professors generally only receive predetermined, and typically low, royalty payments if a product is eventually commercialized. This creates an adverse selection issue, as so-called "entrepreneurial" professors interested in retaining freedom of action surrounding the commercial rights to their research may choose to seek funding for through federal funding mechanisms under which rights normally belong to the university, as under each of the California-based projects mentioned earlier the pharmaceutical company could conceivably in-license the technology through its IP reach-through agreement. Paradoxically, the industry partner could end up funding research that is less likely to have commercial value.

An implication of this issue is that the university alliance managers may face difficulties in finding appropriate projects on which to spend the targeted research funding within partnerships. Evidence from interview research suggests that this was a common problem with several of the California rights-oriented partnerships studied. In these cases, relational mechanisms developed to ensure that the corporate goals were satisfactorily met (or, in the words of one interviewee, to "appease" the industry partners). Examples include the business development office being forced to look around for (non-core) assets from the university that could be used to satisfy the industry partner's expectation of receiving technology for development. An interview respondent also discussed the serious problem of deterring scientists from taking their science "out the back door", that is, to by-pass the normal process of notifying the technology licensing office of a potential discovery through submitting an invention disclosure, and instead attempt to privately commercialize it with a partner or through a start-up.

While some partnerships required that university scientists formally apply for collaborative research funding, which needed to be approved by the corporate partner, in other cases funding decisions were left to university research committees. Doing so creates agency dilemmas created by time inconsistencies: the industry partner guaranteed to provide upfront funding, but cannot specify in advance how university scientists, once funded, will use such funding. The Novartis-UC Berkeley partnership was plagued by this issue. Formal governance mechanisms provided a 'voice' for Novartis, which could use their participation on the internal research committee to push researchers in directions they find valuable. But under the formal rules of the contract the industry representatives could not vote on funding decisions. As a result, the firm could not tell university scientists what to do once they received funding, creating an agency issue as scientists can take funding and pursue their own research interests, which may or may not be of interest to the firm. While the Novartis-UC Berkeley partnerships aimed to create a "research program" in which scientists would need to compete internally to obtain funding, the contract explicitly notes that the program would support general "non-targeted" research (Busch et al., 2004). Novartis was not able to assert significant direction on how the \$25 million was spent, as over the five-year course of the agreement all 25 faculty members within the department received funding (Busch et al., 2004). The laboratory of Michael Freeling, a plant geneticist, was one of the top recipients of funding from the Novartis partnership, receiving \$950,000 over 5 years. A postdoctoral scientist in the laboratory commented that there were "few strings" in accepting the money, as "they never told us what to do" (Lau, 2004, p. 1).

While this discussion has focused primarily on a series of agency problems created by the incomplete nature of long-term contracts structuring industry-university partnerships, it should be noted that, as emphasized within the open innovation literature, the strategy adopted by the pharmaceutical companies in these partnerships was not conducive to achieving collaborative technical relationships. The Novartis partnership with Berkeley is again illustrative. The initial agreement emphasized that UC Berkeley faculty would have an opportunity to collaborate with Novartis scientists and access proprietary technologies. Moreover, Novartis originally planned to spend an additional \$25 million constructing a research facility near the Berkeley campus to spur collaboration. Soon after the collaboration began, however, Novartis decided not to open the research facility, instead offering to provide the UC Berkeley scientists access to workstations, through which proprietary bioinformatics databases could be accessed. There is no mention of any technical collaboration between Novartis and UC Berkeley faculty within the 183-page review of the partnership (Busch et al., 2004). Lacking any day-to-day technical collaboration, it is unlikely that relational contracting norms developed between scientists at the two organizations, which might have helped steer the partnership towards projects of commercial use to Novartis.

With the exception of the Novartis-Scripps partnership (discussed below), none of the long-term partnerships involving California universities or institutes that included broad IP reach-through deals involved the co-location of an industry research center nearby the partner university. This points to a likely conclusion that relational contracting norms, particularly across scientists, failed to develop in these partnerships as well. Low numbers of co-publications across most partnerships support this conclusion. The Novartis-UC Berkeley collaboration only produced 1 co-publication, the PPG partnership with Scripps produced 5 co-publications, while the 15 year J&J partnership with Scripps was modestly more successful, producing 19 co-publications (Sandoz/Novartis-Scripps is discussed below).

Most of the evidence, therefore, points to the conclusion that few rights-oriented partnerships result in major patentable innovations. Most of the interviewees agreed that the performance of these earlier

partnerships was poor for industry. Our interviews also show that J&J and PPG were dissatisfied with the performance of their partnerships with Scripps, leading each firm to eventually terminate their partnership. Our interviews show that most of these partnerships were well intended and universities and companies invested considerable time in managing discrepancies and problems. Nevertheless, bundling together collaboration on science and “cherry-picking” intellectual property rights, which are very different goals and each difficult to manage, proved difficult. The primarily formal contractual mechanisms designed to manage these partnerships – with the possible exception of the J&J partnership – proved insufficient given the severe incomplete contracting problems inherent within these long-term partnerships.

## *2. ‘Tapping-in’ partnerships with a light legal framework*

A second strategy is guided by the goal of industry to collaborate on science with university. Several pharmaceutical companies have developed greenfield research centers close to major universities, usually announcing that their goal in doing so is to “tap in” to local university research networks as part of collaborative R&D strategies (see McKelvey et al., 2003 on co-location and collaboration). Chesborough (2003), through exploring Intel’s strategy of creating “lablets” near several leading research universities, argues that this strategy allows firms to tap in to external sources of knowledge creation while also creating capabilities to internalize it (p. 112-124). This strategy may take longer to produce results, but allows firms to develop technical capabilities and management structures attuned to the firm’s strategy as well as choice of location.

Novartis has been the most active proponent of the networked R&D strategy, which it adopted in the late 1990s (Zeller, 2004; 2010). While the firm still has a major R&D center near its headquarters in Basel, it opened a research center focused on genomics in San Diego near Scripps and University of California, San Diego (UCSD) in 1999, a large R&D center focused on biotechnology-based medicines in Cambridge, Massachusetts near MIT in 2002, and began building an additional R&D pillar in Shanghai, China in 2006. Merck and Glaxo have also opened research centers in close proximity to universities in recent years. Pfizer has created a major business unit focused on regenerative medicine near Cambridge University in the UK and, as we will discuss below, has opened smaller research centers in San Francisco, San Diego, and New York to support partnerships with local universities. Merck has recently opened a facility focused on preclinical drug discovery research in San Diego to support a new partnership with Scripps, also discussed below. Compared to the rights-oriented partnerships, the recent wave of R&D investments by pharmaceutical companies near universities represent more of an organic or “bottom-up” approach focused primarily on collaboration on science and development of capabilities.

A prominent example of the R&D strategy of setting up greenfield sites to “tap in” to local university knowledge is the creation of the Genomics Institute of the Novartis Research Foundation (GNF), a research institute focused on functional genomics that was founded in 1999 by Novartis in close proximity to the Scripps Research Institute and UCSD. In setting up GNF, Novartis took several unusual steps to ensure a strongly academic orientation (Zeller, 2004). Its founding director, prominent chemist Peter Schultz, was allowed to take a full professorship at Scripps in addition to his director role at GNF, and several other principal investigators hired at GNF were also allowed to take part-time positions at Scripps.

While GNF was founded several years after the \$200 million partnership between Sandoz (which became part of Novartis) and Scripps was negotiated, the existence of this agreement meant that GNF inherited a legal framework that granted Novartis an option to own all IP developed through research

collaborations with Scripps. The pre-existing agreement also contained restrictive funding from Novartis aimed at collaborations with Scripps. Within the first few years of founding, GNF announced about a dozen specific collaborations involving scientists with Scripps (Zeller, 2004). Interview research, bibliometric data, and patent data all suggest that the Novartis partnership with Scripps lead scientists to develop scientific collaborations energetically, but that it was difficult to orient these collaborations towards commercially useful projects. Between 1999 and 2006, the year that the IP reach-through agreement between Novartis and Scripps expired, there were 346 co-authored publications. However, only 3 patents were generated from these collaborations. Two senior managers at GNF, when interviewed, confirmed that little came out of the early collaborations sponsored through the \$200 million reach-through agreement.

The high number of co-authored publications between Scripps and GNF scientists during the 1999-2006 period suggests that the co-location strategy, when combined with corporate policies promoting external collaboration, can generate inflows of new scientific knowledge. This finding is supportive of the general open innovation approach, and particularly Chesborough's argument that co-location can promote collaboration. However, the inability of Scripps to generate knowledge in-flows from these collaborations that yielded potential technologies for commercialization suggests that governance issues are also important.

Collaborations with industry can be attractive for academic scientists, as corporate labs often have access to lab equipment, proprietary methods, or specialized reagents or other scientific materials not easily available within academic labs. However, absent strong financial incentives (as the IP from inventions would presumably flow to Novartis), academic scientists may have had limited motivation to steer research towards commercially useful outcomes benefitting commercial scientists involved in a given collaboration (see Balconi and Laboranti, 2006 and Lam, 2011). Moreover, academic scientists have a powerful bargaining position in relation to industry scientists, given the higher status of university professors within major universities compared to most industry scientists (who, perhaps unfairly, are often accorded a lower status, having "moved to industry" from highly competitive academic labor markets) (see, for example, Werth, 1995 and Stern, 2004). While industry scientists may in fact contribute significantly to a project, it seems likely that they will be junior partners within many of these collaborations. Industry scientists also have private incentives to co-publish on important basic research results without consideration of the importance of the research to his or her employer (see Stern, 2004). Publishing, particularly in high status journals, allows industry scientists to remain embedded within academic science networks as well as maintain an external reputation, which can be used to apply for subsequent scientific jobs in corporations or academia (Murray, 2004). Thus, in situations where pharmaceutical firms give free reign to industry scientists to collaborate with university scientists, particularly when laboratories are co-located, it does not seem surprising that collaborations flourished. But there is little reason to suggest that the industry partners will be able to channel research into avenues linked directly to the company's strategic priorities.

Beginning in 2007 Novartis/GNF has changed tact, choosing to develop a less constraining partnership with the University of California, San Diego (UCSD), a university with large, world-class biomedical research facilities (during the 2010-2012 period UCSD's biology and bioengineering departments have been ranked first in the United States (UCSD, 2012). This aim is supported by the development of a simple legal framework, in the form of a "master agreement" with the entire university. This agreement was relatively simple to establish (2-3 months of negotiation), in part because it involves no monetary contribution (e.g. GNF does not pay for research carried out within UCSD labs), but rather contributions in kind. Interviewees argue that success in terms of collaboration rests on equal partnership and

engagement of both the university academic and industry champion that are committed to collaborate. GNF does not issue a general call for proposals for all university professors in the area. Instead, it encourages its scientists to partner with UCSD scientists to submit short proposals, which are reviewed by a decision board comprised of the senior management team of GNF. Proposals are evaluated in terms of their merit, conflict of interests and impact on resources by the decision board and, if accepted, appended to the “master agreement”. Projects are then typically conducted in both the university and GNF labs, often emphasising in-kind contributions from GNF, such as access to libraries of small molecules for screening. The partnership involves no pre-negotiated IP contractual terms. The assumption is that if any IP were generated, it would in most cases involve contributions from both university and industry scientists, so standard rules of inventorship would apply. The interviewees argued that in such “bottom up” partnerships, co-ownership of inventions creates incentives for the university and firm to come to an agreement on IP rights, simplifying negotiations over IP ownership and management.

In developing the master agreement with UCSD, senior managers at GNF emphasized, during interviews, that the primary goal of the partnership was to leverage local academic expertise to push Novartis’s technology, with an emphasis on the development of early stage biology. Scientific publications were listed as the primary metric for assessing the success of the UCSD partnership. The evidence from Novartis suggests that, in terms of promoting collaboration, the local R&D investment strategy appears to be dramatically more successful than the first generation of partnerships discussed above. Between 2007 and 2012 there were 158 articles co-authored by GNF and UCSD scientists.

Investments by pharmaceutical companies to ‘tap in’ to university research appear as a better alternative for industry seeking a “window on science” to earlier arrangements involving up-front payments to departments, as they align the incentives of both academic and industry scientist to collaborate in research. While GNF managers view the UCSD partnership as successful, the partnership has clear limits. GNF managers argued that the partnership creates strong incentives for junior faculty from UCSD to develop projects, and that most partnerships are with junior faculty. Projects with GNF are often used to generate early stage or preliminary data that could be used by junior faculty as the basis of federal grant proposals, increasing the likelihood of funding. Due to the basic research emphasis, the partnership is unlikely to produce scientific findings with direct commercial applicability, such as small molecule drug candidates. Moreover, senior managers at GNF conceded that the partnership does not attract “entrepreneurial professors” to engage in collaborations. While the master agreement shares inventorship rights with academics, such sharing sharply constrains the freedom of action of professors interested in entrepreneurial spin-offs, as venture capitalists or other investors would have to license IP from both UCSD and Novartis, complicating negotiations and potentially limiting the ability to work with other pharmaceutical firms.

### *3. ‘Contracting for innovation’ partnerships with biotech-like governance*

A third strategy involves the industry goal of developing drugs. Pharmaceutical companies see universities as important partners within increasingly distributed innovation networks that in key aspects conform to organizational practices prescribed within the open innovation literature, and have in recent years organized new partnerships that strongly diverge in governance practices compared to other types of partnerships.

New drug discovery-oriented partnerships located in California include:

- a five-year, \$85 million collaboration launched in 2010 between Pfizer and UCSF aimed at accelerating drug development projects, part of a program launched by Pfizer to develop a



series of drug discovery partnerships with leading universities (a second partnership was launched with UCSD in 2012); and

- Merck's funding of \$90 million in 2012 over seven years to create the California Institute for Biomedical Research (Calibr) led by Scripps Research Institute professor Peter Schultz.

In order to pursue the downstream commercial goal of drug discovery, industry has developed more complex governance arrangements integrating formal contracting arrangements that include milestone-related financial incentives modeled on those typically used in the biotechnology industry and decision-making rules designed to foster relational contracting norms. In addition, the new partnerships include industry facilities co-located near university collaborators, created with the goal of fostering close, day-to-day technical collaboration. These partnerships show signs of 'braiding' of legally enforceable contracts and informal or relational practices to support collaboration (Gilson et al. 2009; 2010), and are thus potential examples of the 'contracting for innovation' practices described in section 2.

The Pfizer project with UCSF is particularly interesting, in that the company explicitly frames it as an example of the firm moving towards an open innovation model. The head of the project at Pfizer, Anthony Coyle, notes: "the concept is to make a transition away from the vertically integrated R&D model into smaller, decentralized groups of a truly global nature" (Allarakhi, 2011, p. 3). In addition to the \$85 million in funding, Pfizer has opened a research center dedicated to serving the project in close proximity to the UCSF's Mission Bay campus. The center houses Pfizer scientists with experience in a variety of drug discovery techniques, as well as a number of laboratories outfitted with equipment needed to run a variety of experiments to validate and push forward different types of drug candidates. A portion of project funding is aimed at hiring post-doctoral scientists. Though these scientists are formal UCSF employees and members of the faculty project sponsor's laboratory, post-doctoral researchers are expected to spend a significant amount of time within the Pfizer research center, helping to forge strong collaborative ties. An alliance manager at UCSF directing the project notes that "The Pfizer and UCSF researchers can visit each other's labs, conduct experiments together and participate in joint team-meetings" (O'Brien, 2011, p. 1).

Governance of the partnership between Pfizer and UCSF is based on a "master agreement" that applies to a broad spectrum of targeted research. In contrast to other partnerships, the agreement does not include broad reach-through IP rights over all the research of the investigators in the area but defines clear IP rights boundaries. While opportunities for technical collaboration are at the core of the new Pfizer partnership with UCSF, they are structured by a combination of legal mechanisms and relational rules and incentive structures surrounding IP. A major problem with the earlier partnerships is that, as a *quid pro quo* for receiving upfront research funding, universities were asked to give up downstream IP for subsequent inventions.<sup>1</sup> In contrast, Pfizer's new collaboration with UCSF borrows strongly from biotechnology industry partnership models. Some upfront funding is provided to fund project research, but a portion of the projected \$85 million in funding is dedicated towards milestone payments that will flow towards the university (and professor per university licensing policy) as a standard series of drug discovery and development milestones are met. Moreover, if a drug candidate is selected to move into clinical trials (and transferred into the firm's corporate drug development process), Pfizer will pay UCSF additional milestones and, if the drug is approved for market release, royalties. This model provides much stronger financial incentives for professors at UCSF to fully commit (i.e., to contribute to drug discovery projects with strong potential) to collaborative drug discovery projects with Pfizer. If

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<sup>1</sup> Kloyer and Scholderer (2012) show that (incomplete) contracts granting intellectual property ownership to suppliers are an important deterrent of opportunism in R&D collaboration.

successful, Pfizer's program would provide an alternative to professors thinking about launching a biotechnology start-up – professors would retain similar financial incentives as well as the opportunity to participate in scientific activities relating to the downstream commercialization of science emerging from their lab.

To meet its objectives, Pfizer has introduced a more focused approach towards partnerships, based on research at a more advanced stage than previous partnerships (research that a minimum has identified a target). Furthermore, the partnership is centred on the development of protein biology, though covering any therapeutic type. This more focused approach, allows scientists to publish freely (publication in this area needs less amount of enabling information that, for example, for the publication of small molecules, which would enable competitors to copy), which facilitates collaboration as there is no conflict between the objective of drug development and the academic mission to publish.

Governance in the partnership of Pfizer and UCSF is designed to promote a relational mode of decision-making. The agreement stipulated the creation of a joint steering committee, which selects eight to ten projects for funding each year. The steering committee is composed of four Pfizer scientists and four UCSF scientists. This governance arrangement prevents either partner from having a decisive say in which projects are funded, instead conducting towards consensus-style negotiations. Typically, the academic principal investigator will develop a short proposal (in the words of one interviewee, showing "here is the target") then jointly develop a full proposal with Pfizer scientists, encompassing a detailed scope of work, clear definition of resources/budget around what each part is committed to collaborate. The joint steering committee is charged with project review and selection, and overall management of scientific decisions. A first round of project reviews was conducted in October 2011. Over a two-day process, the steering committee chose five projects for funding, from a pool of twenty-two project submissions (O'Brien, 2011). According to our interviews, the ratio of written-to-funded projects is half at the pre-proposal stage and half again at the full proposal stage. Note the contrast to the Novartis partnership with UC Berkeley, in which UC Berkeley faculty members controlled the majority of votes on the research committee formed to distribute funding from that project. Through creating a system in which neither partner could impose its will on the other, the project selection process conduces towards the creation of relational norms and standards among the steering committee in evaluating proposals. Three more projects were founded to date, and, out of the eight, two were terminated (one due to complicated business decisions on the part of Pfizer, another for scientific reasons). Projects typically last 4 years (from mid stage to early clinic). The agreements contemplate exchange of scientists, who work across locations, depending on infrastructure and equipment (for example, taking advantage of screening libraries in Pfizer, or the radioactive lab of UCSF).

The reliance on relational norms is also noticeable in the broader management. The office of innovation, technology and alliances at UCSF is heavily involved in making sure the steering committee meets quarterly, that the calls for proposals is issued, projects selected and reviewed. It bridges cultural gaps, monitors and intervenes when problems need to be addressed (e.g. budget discrepancies). In the words of one interviewee this "takes that tension out of the relation", the office acting as an advocate for the academic principal investigator, helping to moderate if Pfizer has a problem with the relation. Since projects are long term, they have fluctuations in resources/budget that need careful planning. Under this agreement, IP rights are jointly owned, with Pfizer having an exclusive (time limited) option. The terms of licence is negotiated, within some typically pre-determined boundaries, depending on the case. According to the interviewees the two partners have incentives to negotiate in good faith and to arrive to an agreement, with clauses in the contracts to facilitate this, such as ability to extend the exclusive option window for a small fee, for example.

Co-location is argued to have many advantages to build collaborations. The projects contemplate monthly meetings of each project team, ad hoc interactions, and especially the joint running of in vivo experiments (as they are different ways of structure them in academia and industry, discussing how to run them is argued to bring out what is expected from the experiment).

The new partnership of Merck and Scripps differs from Pfizer’s approach in one significant way: rather than work with a university or department, it steers finance directly towards professors. The professor selected, Peter Schultz is well-known biomedical scientist and also academic entrepreneurs (Schultz, in addition to his work as director of GNF has founded eight start-ups). By creating direct collaborations with leading professors, the pharmaceutical companies involved may be attempting to channel future scientific discoveries directly to the pharmaceutical firm as opposed to start-ups (Martino, 2011), creating strong financial incentives for professors to commit to the collaboration. Merck’s strategy also differs from Pfizer in that they are allowing Peter Schultz to direct the collaborative drug discovery California Institute for Biomedical Research (Calibr) funded by the project, organized as a non-profit research institute. However, Merck scientists participate on the organization’s scientific advisory board and works closely with the organization (Timmermann, 2012). The new institute has a scientific board headed by Harvard University's professor Christopher Walsh and an independent board of directors chaired by the founder and managing partner of 5AM Ventures, John Diekman, who oversees the activities of the institute.

We can see that, in order to succeed in meeting their goal, technical collaborations organized by pharmaceutical firms with the purpose of developing drugs must be explicitly linked with legally enforceable obligations and relational and incentive structures designed to elicit useful cooperation for innovation from university scientists. It is unknown whether these recent partnership agreements will become an important source of innovation for the pharmaceutical firms involved, or if other companies will emulate the new model. Our study, however, supports the argument that innovations in contracting structures and licensing provisions within the new agreements are likely to lead academic professors to commit more fully to pursuing valuable research ideas towards the partnerships. The adoption of open innovation strategies by pharmaceutical firms, facilitated by the creation of partnership-specific research laboratories, will facilitate the uptake of such research into collaborations more likely to produce innovations.

**Concluding discussion**

The article has examined the relationship between open innovation and governance, showing that incomplete contracting challenges are pervasive within industry-university partnerships and demonstrating that different types of industry-university partnerships necessitate the creation of varying governance arrangements, in terms of the formal and informal contractual mechanisms used. Table 3 summarizes the characteristics of the three main types of partnerships that can be derived from our findings. Each type of partnership creates unique governance challenges.

**Table 3: Main features of different types of partnerships**

	<b>Rights-oriented partnerships</b>	<b>Tapping-in partnerships</b>	<b>Contracting for innovation partnerships</b>
<b>Alignment of goal of industry and incentives for</b>	Goals are not fully aligned: industry has dual goal of industry	Goals are aligned: university and	Goals are aligned: university and industry aim to

<b>university</b>		collaboration and broad expectation of technology development but university's aim is to raise money for hiring top scientists and infrastructure	industry aim to collaborate on science and develop capabilities	commercialize technology (e.g. develop drugs)
<b>Governance of the partnership</b>	<b>Co-location</b>	No	Yes	Yes
	<b>Funding</b>	Upfront funding: unrestricted funding plus restricted project funding	In-kind contribution	Restricted funding plus biotechnology-type milestones
	<b>IP</b>	Industry reach-through IP, first right of refusal on most research; downstream royalties	Joint inventorship	Industry, royalties negotiated
	<b>Formal and relational contracting mechanism</b>	Strict legal framework: formal contract and weak relational governance to make sure corporate goals are satisfactorily met	Light legal framework: master agreement with rights determined by inventorship; designed to remove obstacles to collaboration at scientific level	Braiding of formal and relational mechanisms to enable collaboration at scientific level

First, we can identify a first set of partnerships that we have called 'rights-oriented' with the dual goal of obtaining access to university research and reach-through IP rights emphasizing formal contracts. The use of upfront funding combined with weak financial incentives for university scientists to participate creates pervasive governance challenges for these partnerships. In contrast, there are two further types of partnerships typically aided by investment in corporate R&D facilities near universities. The more simple 'tapping-in' partnerships have been highly effective in generating research collaborations, but provide weak incentives for entrepreneurial professors to participate and are limited in scope to basic research collaborations with more limited direct commercial applicability. The third type of partnerships ('contracting for innovation') focuses directly on eliciting the participation of entrepreneurial professors and aims to develop and commercialize technology. For this purpose, companies have created much stronger financial incentives to create commitment and focus, modeled on biotechnology-like governance and funding arrangements, combined with co-located research facilities than can help parties monitor each other's activities and better align incentives through generating relational contracting norms.

While it would be incorrect to suggest that other types of long-term partnerships between industry and universities do not exist, the three forms of partnerships discussed here are useful ideal-types due to

their differences in aims and governance. Moreover, other examples of each type can be readily identified, though often with differences in some variables, such as whether co-location exists or in contractual arrangements developed, that could be used to drive future research studies. For example, in 2012 Novartis signed a master agreement with UCSF that is identical in structure as the existing agreement with UCSD, but will not benefit from a co-located laboratory. In 2011 Gilead launched a rights-oriented partnership with Yale University. However, this partnership is focused on research in one therapeutic area, cancer. While providing \$10 million per year in funding, only 4 years of funding is initially guaranteed, with another 10 years of funding available if the partnership is viewed by Gilead as succeeding (Schlacter, 2012). Future research might examine whether a more focused collaboration, combined with a shorter initial project duration yields stronger results than found within rights-oriented projects of broader scope and longer duration. Since 2010 partnerships resembling the ‘contracting for innovation’ type have been particularly prominent. Pfizer has launched initiatives with UCSD and a consortium of New York universities modeled on its UCSF collaboration, and has also launched milestone-oriented collaborations with professors at University College, London. Beginning in 2011 the pharmaceutical firm GlaxoSmithKline launched a program to form drug discovery partnerships with up to ten “academic superstars” found in universities across the world. They have since formed partnerships with professors at University College London, Cambridge University, and the University of Dundee in the United Kingdom, and Yale University and Vanderbilt University in the United States. These partnerships share the emphasis on technical collaboration and milestone-oriented financial incentives with the Pfizer and Merck partnerships discussed above. However, GlaxoSmithKline has chosen not to co-locate research laboratories near its partners, choosing instead to draw on the firm’s existing research laboratories to service collaborations. Glaxo has also chosen to target individual professors rather than working with universities or departments (Schlacter, 2012). While the focused emphasis on drug discovery, promise of technical collaboration, and use of milestone oriented financial incentives are similar to the Pfizer-UCSF partnership, future research may useful examine whether the differences in partnership structure impact performance.

Our work contributes to the stream of research on open innovation in two ways. First, it deals with the governance of the creation of innovation in an open innovation context. As argued earlier, the literature on open innovation has neglected attention to governance. When it has explored governance, it has tended to focus primarily on transactional issues surrounding the search or acquisition of existing innovations, rather than the governance of the collaborative creation of innovation. Second, we focus on open innovation in science-based sectors, rather than technology sourcing. In this context, collaborations are long term and involve complex fields of knowledge and uncertainty. This makes governance issues (including incomplete contracting) all the more salient. The imperative is to develop governance structures that encourage relationship-specific investments, iterative collaboration and limit the risk of opportunism.

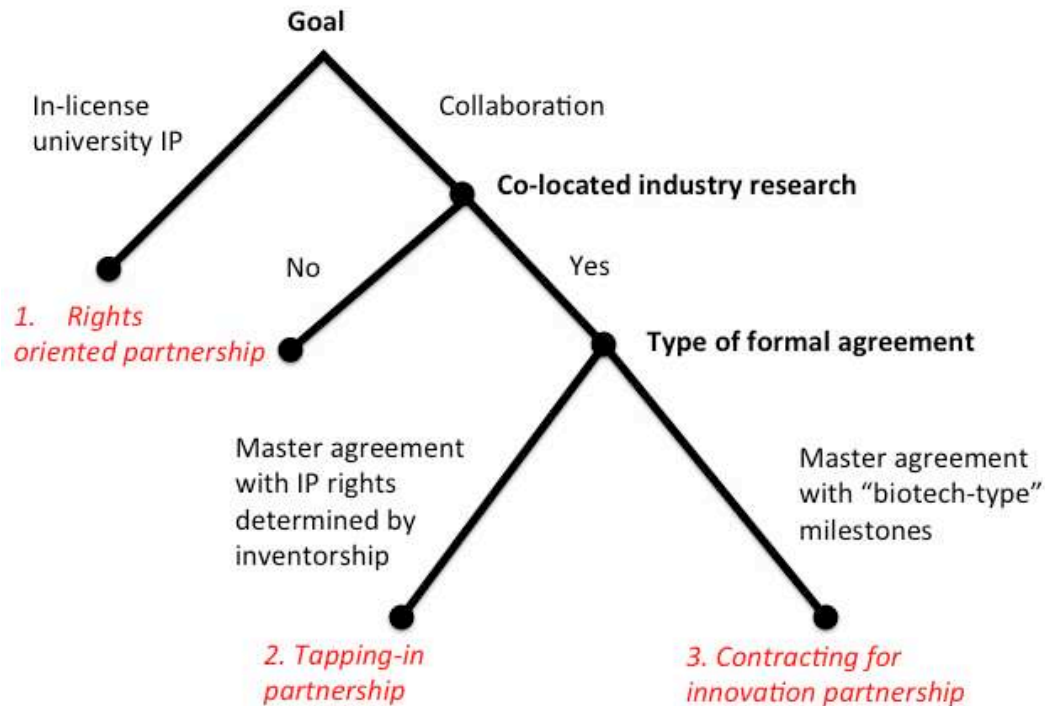
We contribute to the stream of research on open innovation by building a theoretical bridge between this literature and the literature on contracting, showing that it is not sufficient for partners to recognize the value of cooperation and organize a division of labor consistent with the open innovation paradigm. Relation-specific investments can be encouraged and opportunism limited by following elements of a contracting strategy that combines legally enforceable obligations with implicit or relational obligations that “establish formal governance structures regulating the exchange of highly revealing information but do not necessarily impose legally enforceable obligations actually to buy and sell products” (Gilson et al., 2009, p. 3). This can encourage interactions that develop joint understanding, learning, and encourage, over time, relation-specific investments that can result in innovation. Although the results of the recent industry-university partnerships organized under the banner of open innovation are too new to

evaluate, they include more sophisticated governance structures and relationship-specific research and development investments by pharmaceutical firms that are more likely to incentivize university scientists to participate in drug discovery collaborations with pharmaceutical industry scientists.

Pharmaceutical firms have developed several governance ‘experiments’ with the aim not only to access the knowledge of top academic scientist articulated in the course of research (before it may be officially diffused through presentations or publications or codified in patents) but, also, to steer the research into areas of strategic interest for the firm, encourage innovations of commercial value to the firm, and reduce conflicts over IP. As emphasized in the open innovation literature, proximity (both geographically and relationally) to qualified universities that deliver tacit knowledge of a cognitive type is increasingly being pursued by pharmaceutical firms (Balconi et al., 2007). This form of tacit knowledge, mostly uncodifiable, involving intellectual skills to analyze and solve problems, a process of search embodied in individual scientists (Balconi, 2002), is considered a fundamental resource for the pharmaceutical industry. The light legal framework and combination of formal contractual and relational elements in a number of industry-university partnerships enables the explicit ‘review’ of the tacit knowledge held by scientists across organizational barriers to pharmaceutical firms and has built incentives to steer this search into areas of interest of the firm, addressing IP issues before they arise.

Our work adds to the stream of research on open innovation by showing how organizations engaged in open innovation govern their collaboration and how new arrangements have been designed to mitigate incomplete contracting problems. As such, we can see firms as seeking alignment with forms of governance that best solve particular innovation problems (Felin and Zenger, 2012). This study should also be beneficial for management practice, showing how different contractual structures operate in open innovation contexts. These insights are likely to be relevant to other forms of highly collaborative open innovation arrangements in science-based sectors, including those between firms. Figure 1 summarizes some of the relevant considerations in the form of a decision flow chart. It indicates that a university or company seeking to create innovation in an open innovation context must consider a legal framework consistent with the broad goals, obligations, and incentive structures of parties to cooperate within a partnership. For example, where there is co-location (or the possibility of co-locating industry and university research), there may be a greater likelihood of developing collaborative research. This reasoning is consistent with the idea that technical collaboration can generate relational contracting norms and facilitate monitoring, but with a back-stop provided by an appropriate legal framework.

**Figure 1: Flow chart for decisions regarding governance arrangements in industry-university partnerships**



Further research at a larger scale needs to examine more carefully the workings of the informal and formal elements of new governance structures in open innovation partnerships between industry and university (or other organizations, for that matter). A number of questions remain to be explored through further detailed research: which particular elements in the governance structure aid (more than others) in the building of collaborative relations for the creation of innovation in open innovation? How do formal mechanisms induce informal behaviour in open innovation? What particular governance mechanisms encourage relationship-specific investments in practice? When have conflicts/disagreements between collaborators happened in practice and how have they been addressed? When do the legal incentives overpower informal mechanisms designed for collaboration in open innovation?

Also, the paper has not addressed the often discussed and difficult issue of whether it is suitable for companies to appropriate research which may partly funded by government. Nor does it address the role of university in generating much needed lower-cost medicines and publicly accessible research tools, and the advantages and disadvantages of receiving company funding in this respect. Important criticisms have been raised about the patenting of biomedical research tools, including their potential to inhibit scientific inquiry and the development of life-enhancing treatments (Heller and Eisenberg, 1998). Also, new governance structures are being set up to share resulting patented innovations for non-commercial research purposes or could facilitate a secondary market in compounds not exploited commercially by pharmaceutical firms (Chesbrough and Chen, 2012). Following from this research, it would be worthwhile to explore how governance arrangements in open innovation between industry and university can support these initiatives.

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