

Strategic Alliances: Trading Ownership for Capabilities

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Abstract: Increases in alliance activity between research-intensive firms and incumbents is puzzling since it is challenging to contract upon highly uncertain R&D activities. Our paper extends prior research by exploring the relationship between firm capabilities and gains from trading ownership rights. This link is important because the allocation of ownership rights has been shown to influence alliance outcomes. Using data based on a survey of biotechnology firms, we find that both current and future capabilities provide strong explanatory power for understanding firm valuation of ownership rights. These ownership rights are ultimately allocated across firms in order to maximize their gains from trade.

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1 INTRODUCTION

Firms are often unable to sustain continuous high levels of productivity over long periods of time without accessing knowledge from beyond their boundaries; even leading firms require external knowledge to develop new innovations (Arora *et al.*, 2001). This growing dependence upon external technology has caused the number of vertical transactions to dramatically increase. Correspondingly, there has been a vibrant increase in research focused on the contractual aspects of these inter-firm transactions since, as Parkhe argued, “the performance of a strategic alliance will be significantly related to the pattern of payoffs characterizing it” (1993: 799). Ultimately, this means finding an efficient and incentive compatible allocation of rights within these contractual agreements thereby inducing behavior that optimizes project returns. In other words, *ex ante* allocation of rights should be optimized in order to maximize *ex post* gains from trade. This suggests that internal valuations of rights play an important role in this process. While little is currently known about the formation of these valuations and how gains from trade emerge, understanding them adds to our knowledge about property rights distribution within alliances, which has demonstrated implications on alliance performance (Lerner *et al.*, 2003) and, ultimately, firm performance (Shan *et al.*, 1994; Rothaermel and Deeds, 2004).

Firms in various industries see significant benefits associated from reallocating ownership rights as an alternative owner might be able to “manage the company more efficiently” and generate greater value (Manne, 1965:113; Serrano, 2011). In his assessment of assets Demsetz argues that ownership should follow the benefits of specialization in knowledge; they “should gravitate to the party who possesses the specialized knowledge necessary to do a good job of setting the general goal of the cooperative effort and monitoring the degree to which various owners of inputs accomplish their tasks” (1997: 34-35). These specific assets and knowledge and their ability to marginally impact a project are directly tied to a firm’s underlying bundle of capabilities. This bundle should cause a firm to more highly value specific rights thereby aligning internal valuation with capabilities. Since rights come with a cost and an obligation, firms

without a specific capability should be willing to trade relevant rights to their partner if that partner has the capability.

Recent studies on ownership rights have focused on their allocation (*e.g.*, Lerner and Merges, 1998; Ciccotello and Hornyak, 2000; Higgins, 2007; Elfenbein and Lerner, 2003; 2012), role in value appropriation (Adegbesan and Higgins, 2011), reducing opportunistic behavior (Kloyer, 2011; Kloyer and Scholderer, 2012) and impact on alliance outcomes (Lerner *et al.*, 2003); however, researchers have had to make two limiting assumptions: (1) homogeneity of rights; and, (2) independence between rights. By homogeneously valuing rights information is not discernible about their relative importance. Moreover, having to assume independence between rights discounts the notion that they may be bundled (and negotiated) together. This may be of particular concern for studies that focus on specific rights (*e.g.*, Lerner and Malmendier, 2010) since it is possible that these rights are not actually negotiated or allocated independently. These limitations are not unknown and exist because researchers have only been able to analyze *ex post* allocations of rights contained in executed contracts.

Using data from a survey of international biotechnology firms we study the relationship between firm capabilities and their internal valuation of ownership rights and in doing so we are able to overcome the aforementioned limitations and make several contributions to the literature. First, we present empirical evidence on the existence and extent of heterogeneous internal valuations of ownership rights. Using factor analysis we identify bundles of rights that are interdependent upon each other, which we categorize as either “upstream” or “downstream”. We argue that capabilities and control should be aligned whereby internal valuations of ownership rights flow from a firm’s specific capability set. Consistent with this notion, we find that current firm capabilities drive valuation of rights. This suggests that by aligning strategy and organizational activities (Gawer and Henderson, 2007) firms optimize their valuations for specific rights, which in turn, should influence eventual *ex post* allocation and, ultimately, their gains from trade.

Moving beyond the static view of current capabilities we also surveyed firms about their future plans to expand downstream in order to acquire commercialization capabilities. For firms that acknowledged an expansion plan we find that they value bundles of rights that are not only consistent with their

current capabilities but also rights consistent with their expansion plan. This suggests that firms appear to begin to value ownership rights that match future capabilities *before* they acquire those assets. Obtaining such rights provides firms with an incentive to build up these capabilities; a view consistent with the incentive systems literatures (Gibbons, 2005). Moreover, firms may enter into alliances in order to learn and profit from partner experience when building these capabilities. Despite this desire to learn and acquire capabilities it may be the case that such capabilities end up being duplicated thereby increasing costs. It may also be the case that the firm has an undetermined downstream expansion strategy. In either of these two cases such a bundling is inconsistent with the literature (*e.g.*, Demsetz, 1988; Hart and Moore, 1990) and is inefficient since rights are not costless to obtain and come with an obligation.

Finally, prior literature stresses the importance of alliance capabilities and documents a positive relationship with firm-level patenting (Shan *et al.*, 1994), positive stock market responses (Anand and Khanna, 2000; Kale *et al.*, 2002) as well as with alliance performance (Kale *et al.*, 2002; Hoang and Rothaermel, 2005; Schilke and Goerzen, 2010). We add to this literature by demonstrating that the strength of alliance capabilities is positively related to internal valuations of upstream ownership rights. While previous studies have focused on the direct effect of alliance capabilities on alliance performance, our results imply that these capabilities impact the underlying contractual structure of an alliance, which is long before performance can be assessed. This alignment with rights provides an additional explanation for the link between capabilities and performance.

2 RELATED LITERATURE

2.1 Current capabilities and internal valuation of ownership rights

Central to the capabilities perspective is the idea that firms differ in their capabilities or resource positions, and that such heterogeneity explains market position (Gawer and Henderson, 2007) and is a source of performance difference across firms (Barney, 1991; Peteraf, 1993; Henderson and Cockburn, 1994). These capabilities, which can give rise to competitive advantage, are not merely simple assets but rather compound asset structures that are built over time and can be path dependent (Teece *et al.*, 1997;

Deeds *et al.*, 1999). Two assumptions underpin the capabilities perspective: (1) firms are heterogeneous with respect to their capabilities or resource profiles; and, (2) these capabilities or resources are not perfectly mobile across firms (Barney, 1991).¹

The emphasis on firm heterogeneity resulting from differences in capabilities is a particularly important notion in explaining vertical specialization and cooperation. The entirety of the value chain for an industry is composed of various activities (*e.g.*, research, development, manufacturing, sales and marketing) that often demand very specific capabilities. In some instances firms with the specialized capabilities carry out certain steps of the value chain. For example, in the pharmaceutical industry, contract research organizations have emerged and focus on clearly defined research tasks.

In general, activities that require the same or closely related capabilities are deemed “similar”. These similar activities are seldom complementary, since complementary activities typically occupy different stages of the value chain. Richardson (1972: 888) argues that firms “...would find it expedient, for the most part, to concentrate on similar activities”, since incorporating “dissimilar” activities may lead to diseconomies of scope and/or increased information or transaction costs.

Scholars have widely documented that firms are increasingly specializing along the value chain with research intensive firms often selling or licensing their intellectual property to incumbents in the market for technology (Bresnahan and Gambardella, 1998; Arora and Ceccagnoli, 2006) or the market for ideas (Gans and Stern, 2000; Gans *et al.*, 2002; Haeussler, 2011). Pharmaceutical firms often hold important downstream capabilities or co-specialized assets that their research intensive, biotechnology firm partners often lack, including manufacturing, distribution, marketing and sales (Chan *et al.*, 2007; Haeussler *et al.*, 2012). Likewise, biotechnology firms have been a source of new, innovative upstream

¹ Two strands of literature are particularly central to organizational strategy. One strand focuses on the theory of the firm (*e.g.*, Williamson, 1985; Coase, 2006) and accentuates organizational efficiency, but has been criticized (Langlois, 1992; Kogut and Zander, 1992) for saying little about organizational heterogeneity (Foss and Klein, 2008). In contrast, the second strand, based on the capabilities perspective (*e.g.*, Wernerfeldt, 1984; Barney, 1991; Teece *et al.*, 1997), is a theory of organizational heterogeneity and sustainable performance differences, but lacks the ability to address organizational forms and governance arrangements that create capability differences (Foss, 1996a; 1996b) and is unclear on the mechanisms between capabilities and economic organization (Foss, 2005). Our focus is on this second strand or capabilities perspective.

research for incumbent firms (Higgins and Rodriguez, 2006). Moreover, for many biotechnology firms, alliances are important sources of financing and revenues as well as important means to bring a product onto the market.

If we accept the assumption that the capabilities perspective implies that firms possess different bundles of capabilities, then this has direct implications for contracting and on potential gains from any trade. A firm's current capability set should be taken into account when contracts are negotiated. Firms possessing capabilities in a specific area not only provide them with unique expertise but may also make them particularly capable of coping with problems associated with that area. Indeed, capabilities derived from specific firm knowledge have been identified as a source of competitive advantage (Kogut and Zander, 1996). Demsetz (1988: 157-158) suggests that partners who lack capabilities or knowledge in one relevant area "... must have their activities *directed* by those who possess (more of) the knowledge". Put differently, the right to decide should rest upon how effectively a firm is able to decide and this depends on their capabilities. As such, capabilities and ownership should thus be aligned whereby internal valuation of rights flows from a partner's specific capability set. In this instance, firms also minimize potential transaction costs because they are not trying to negotiate or craft terms for which they have no expertise or limited contract design capability (Argyres and Mayer, 2007).

Unlike previous studies that emphasize that firms strive for more rights in the sense of "more is the better" (*e.g.*, Lerner and Merger, 1998), we argue that the current capabilities set of a firm directly influences gains from trading rights. Retaining more rights might not always be beneficial: firms can be better off if they trade away ownership to a partner whose resources or capabilities set makes them better positioned to decide or direct alliance activities (*e.g.*, a pharmaceutical partner might be better equipped to litigate or direct patent infringement suits than a research intensive firm). This view suggests that firms act in a manner whereby they form internal valuations for rights that match their capabilities but that they are also willing to trade away rights that align with the capabilities of their partners. In sum, more may not always be better if the rights are not aligned with firm capabilities.

We take the view that an obligation comes with ownership. This obligation, which is often legally binding, requires a firm to make decisions in the best interest of the partnership. If a firm has limited knowledge or capabilities to arrive at the best solution, then it is possible that only a sub-optimal level of success can be achieved. Given that in high-tech industries many incumbent firms have come to rely extensively on research intensive firms (Ceccagnoli *et al.*, 2010) for new research inputs, it is critical that these firms attempt to construct contracts that will induce optimal performance in hopes of achieving a more favorable outcome.

This reliance on external technologies in the biopharmaceutical industry tends to be between large incumbent, pharmaceutical firms and smaller, research-intensive, biotechnology firms. As such, the majority of the relationships between these firms tend to be vertical in nature. Following our notion that firms will more highly value rights that match or align with their capabilities, we propose that firms with strengths in upstream capabilities will more highly value ownership rights related to upstream activities whereas firms with strengths in downstream commercialization capabilities will more highly value ownership rights related to these downstream activities.

2.2 Future commercialization capabilities and internal valuation of ownership rights

We recognize, however, that firms are not static entities but are constantly developing and changing. This also means that the capability bundle of a firm will continue to develop both inside and outside of partnerships. Scholars have emphasized the ability to change and quickly develop capabilities for sustained competitive advantage. This ability to continuously renew capabilities has come to be known as “dynamic capabilities” (Teece *et al.*, 1997; Eisenhardt and Martin, 2000), “dynamic core competencies” (Danneels, 2002) or “second-order competences” (Danneels, 2008).

The existing literature on property rights has focused on the “*static* management of innovation” (Aghion and Tirole, 1994: 1206). However the dynamic aspects of research activities are particularly important with regard to vertical alliances. One of the most widely cited motives for collaboration is the acquisition of capabilities (Hamel *et al.*, 1989; Shan, 1990; Hamel, 1991; Powell and Brantley, 1992; Mody, 1993; Khanna, 1996; Mowery *et al.*, 1996). In this instance, firms enter alliances in order to learn from a

partner. This is consistent with Helfat *et al.*'s (1997) notion of dynamic capabilities as “the capacity of an organization to purposefully extend, create or modify its resource base.” Evidence suggests that this is the case with acquiring downstream commercialization capabilities (*e.g.*, Hamel, 1991; Khanna *et al.*, 1998; Rothaermel and Deeds, 2004). Hsu and Wakeman (2012), for example, argue that biotechnology firms enter alliances with pharmaceutical partners in order to observe commercialization practices thereby acquiring the necessary skills to commercialize future products alone. As such, we expect biotechnology firms that plan on expanding downstream will first want to learn from existing alliance partners.

When firms enter into alliances in order to gain access to other firms' capabilities, the alliance learning effect may be greater when they also acquire the rights to decide on activities associated with the (aimed) activity. For example, research on joint ventures suggests that parent learning is greater when managers of the parent firm are involved in decisions and spend time at the joint venture (Inkpen and Crossan, 1995). Therefore, we assume that biotechnology firms that do not have current downstream commercialization capabilities but have a desire to expand downstream will more highly value ownership rights related to commercialization activities versus firms that do not have the intention to expand downstream.² Further, in the case where the biotechnology firm currently has downstream commercialization capabilities, we would also expect them to value the relevant related ownership rights.

The question arises as to why biotechnology firms that specialize in upstream R&D activities would want to acquire downstream commercialization capabilities. Hsu and Wakeman (2012) provide two possible reasons stemming from the economics of organization literature. First, they may want to mitigate possible small numbers bargaining problems. Pisano (1990) notes that biotechnology firms that are highly specialized or focused in one therapeutic area may become dependent upon on a limited number of commercialization partners. In such a situation, the biotechnology firm risks potentially exposing itself to ‘hold-up’ problems during the negotiation process. Second, the biotechnology firm may want to strengthen their appropriability position over the profit stream from its innovation. Teece (1986) argues that acquiring

² A parallel proposition would be that firms with an upstream expansion strategy more highly value upstream rights. However, in our setting, an upstream expansion is unlikely as many of firms are spin-offs from a university or public research lab and already perform basic science.

co-specialized capabilities, in this case downstream commercialization capabilities, increases a firm's appropriability over an innovation.³

Notwithstanding this desire to acquire capabilities and learn, it is possible that certain capabilities end up being duplicated leading to an increase in costs. In fact, Mowery *et al.* (1998) provide evidence that this type of technological overlap increases in cooperative arrangements. As such, firms potentially face a dilemma: partners may have competitive, as well as collaborative aims vis-à-vis each other where they try to acquire one another's capabilities. This may well result in a "competition for competence" that ultimately destabilizes the relationship (Hamel, 1991). In the biopharmaceutical industry, for example, Rothaermel and Deeds (2004) observe that when biotechnology ventures grow they tend to withdraw from their upstream focus in order to develop and commercialize promising projects through downstream expansion, which ultimately leads them to compete with former alliance partners.

2.3 Alliance capabilities and internal valuation of ownership rights

Besides capabilities associated with specific activities along the value chain, the alliance capability of a firm may also impact how they internally value various ownership rights. Alliance capability is the ability to effectively capture, share, monitor and distribute alliance management know-how and can take the form of dedicated alliance personnel, databases, tools, metrics and alliance experience (Kale *et al.*, 2002). Prior research documents a positive relationship between alliance capability and increases in firm-level patenting (Shan *et al.*, 1994), positive stock market responses (Anand and Khanna, 2000; Kale *et al.*, 2002) as well as on alliance performance (Kale *et al.*, 2002; Hoang and Rothaermel, 2005).

Notwithstanding these findings, different types of alliances and different tasks within these partnerships may make alliance capability more or less important. For example, existing work points to the

³ It is theoretically possible that a firm that does not currently have downstream commercialization capabilities and has *no* intent or plans to develop them could still highly value the relevant downstream rights in order to mimic those firms that intend or plan to downstream integrate. If it is the case that firms make the move downstream and develop commercialization capabilities in order to protect against potential hold-up problems, these other firms may be trying to mimic those firms without making the requisite downstream investment. While a theoretic possibility, we do not see this in our data. There is a significant difference in the internal valuations for downstream rights between those firms that intend to downstream integrate and those that do not (Wilcoxon rank-sum test of differences in two samples: $p < 0.001$).

strength of alliance capabilities in being particularly important for upstream (R&D related) activity. In their study of the automotive industry, Clark and Fujimoto (1990) find that central coordination of development decreased the time and cost involved in developing new product designs. Similarly, studying the pharmaceutical industry, Henderson and Cockburn (1994) suggest that higher-order organizing mechanisms are particularly useful to coordinate R&D. They argue that having an individual or team responsible for coordinating internal and external R&D increases productivity. Further, Hoang and Rothaermel (2005) find that the alliance experience of biotechnology firms increases joint R&D project success. However, alliance experience of their pharmaceutical partner did not provide the same effect, which they argue may be the result of being “further down the learning curve”.

March (1991) and Levinthal and March (1993) present an exploration–exploitation framework to understand the needs of firms at different stages along the value chain. Applying this framework to analyze alliances between biotechnology and pharmaceutical firms, exploration is related to upstream research activities aimed at discovering something new (Koza and Lewin, 1998). These activities are most often performed by the biotechnology firm and are highly uncertain with most biotechnology drug candidates not making it into clinical trials (Giovannetti and Morrison, 2000). In this highly uncertain context, greater alliance capabilities are clearly beneficial to the firm. For example, they may allow the firm to respond more quickly to underlying changes in a specific project. On the other hand, committing greater alliance capabilities or resources to a project comes with added risks. One way to mitigate some of this potential risk is through the bundle of upstream ownership rights. Firms not only aim to own underlying intellectual property (IP) but they can also avoid potential appropriation via reversion rights (Lerner and Malmendier, 2010). As such, we expect biotechnology firms that commit a larger percentage of their alliance capabilities to a project to more highly value upstream rights.

In contrast, this means exploitation activities are related to downstream activities including: later-stage development, regulatory approval, manufacturing, and marketing. Downstream activities are typical-

ly more regulated and have lower uncertainty than upstream activities.⁴ Again, focusing on the biopharmaceutical industry, pharmaceutical firms have developed the legal and regulatory competence, manufacturing, distribution and marketing capabilities (Cullen and Dibner, 1993) needed to take products to market (Rothaermel and Deeds, 2004; Chan *et al.*, 2007). Many of these activities will end up being controlled by the pharmaceutical partner. As such, alliance capabilities of the research-intensive (biotechnology) partner should become less important in this context.

3 DATA AND METHODS

3.1 Research setting

Given our research focus on vertical R&D relationships between large incumbent firms and smaller, research intensive firms we choose the international biopharmaceutical industry as our research setting. This industry is rife with young technology firms that often have promising ideas but lack the financial resources and complementary assets in order to move those ideas to market. On the flip side, it is an industry where incumbent (pharmaceutical) firm pipelines are shrinking (Higgins and Rodriguez, 2006) and they are becoming ever more dependent upon external research (Ceccagnoli *et al.*, 2010) in order to keep their downstream co-specialized assets fully deployed (Chan *et al.*, 2007). This supply of new promising technologies coupled with an increased demand for them have created a robust market for technology. This is reflected in an increase of over 100% in the number of biopharmaceutical research-based alliances between 1996 (1,023 deals) and 2007 (2,348).⁵ In addition to the prevalence of deals, the industry faces long and expensive development cycles coupled with low probabilities of success. This makes the allocation of ownership rights all the more critical, especially given the potential payoffs, which can exceed well into the billions of dollars per year for a “blockbuster” product.

⁴ In the pharmaceutical industry the FDA regulates most aspects of downstream development. Strict regulatory rules govern clinical phase testing as well as the manufacturing and marketing process. In contrast, upstream activities, primarily those before clinical testing, are fairly unregulated. Prior work has documented a decrease in uncertainty in developing a new drug (*i.e.*, an increase in transition probability) as a potential candidate moves through the various stages of clinical development; the risk of failure is greatest during upstream activities (*e.g.*, Krieger and Ruback, 2001).

⁵ Authors calculation based on information accessed from the Deloitte Recap database, www.recap.com. We thank Deloitte Recap for access to their data.

These external transactions, it is important to note, are, at least, two-party deals. We focus on the perspective of the small, research-intensive, biotechnology firm. Lerner *et al.* (2003) demonstrates that right allocations consistent with theory (*e.g.*, Aghion and Tirole, 1994) have performance implications with respect to alliance outcome. One of the goals of our research is to provide intuition on how managers might improve alliance outcomes. As such we need to understand how suppliers of new technology form internal valuations of specific rights.

3.2 International biotechnology survey

In contrast to previous studies that analyze *ex post* allocation of rights in alliance contracts (*e.g.*, Higgins 2007; Lerner and Merges 1998; Lerner *et al.*, 2003; Elfenbein and Lerner, 2012; Adegbesan and Higgins, 2011), our empirical strategy sets out to measure a firm's *ex ante* valuation of ownership rights.⁶ This kind of data is unavailable in public databases but is nonetheless desirable. By focusing on firm valuations we get a more complete understanding of how they view particular rights without the possible distortion caused by the negotiating process or appropriation issues due to bargaining position. We therefore designed and administered an international survey in 2009.

We approached biotechnology firms located in North America (USA and Canada) and eleven European countries (Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Sweden, Switzerland, United Kingdom). Firms that were not founded in one of the thirteen countries, were subsidiaries of foreign firms, were younger than one year old or ones for which we could not obtain adequate contract information were excluded. Our sample was identified through several industry databases (*e.g.*, Bioscan, Biocom, Dechema, as well as regional databases like Erbi). Our working sample started with 463 North American (15 Canadian and 448 US) and 1,758 European firms. Each firm received a personalized email addressed to the head of management or head of business development (if existed) requesting that it be directed to the person responsible for entering and negotiating alliances, inviting them to participate in

⁶ The focus on *ex post* allocations of rights in the literature has been as a result of data availability. Much of the work in this field has focused around data made available by Deloitte Recap. Other researchers, for example, Ciccotello and Hornyak (2000) have constructed their own proprietary datasets using data from the US Air Force.

the on-line survey. Overall, 365 managers filled out the survey resulting in an average response rate of 16%.⁷

We tested for potential non-response bias by comparing the answers to questions from the first wave of respondents with the last wave of respondents (Armstrong and Overton, 1977). We perform a conservative non-response analysis by testing whether the answers to our dependent variables concerning the valuation of rights and variable controlling for the age of firms differ significantly between the first 10% and last 10% of respondents. Our variable distinguishing between these two sets of respondents was not significant in either specification; non-response bias does not appear to be an issue.

Common method variance might be a concern since all data are self-reported and collected through the same questionnaire during the same period of time (Podsakoff and Organ, 1986). In order to avoid this potential bias we placed the questions in a manner that did not reveal the intention of the analysis. In addition, we conducted a Harman test for the presence of common method effect (Podsakoff and Organ, 1986). We used unrotated principal component factor analysis to determine the number of factors that were necessary to account for variance in the variables. If a substantial amount of common method variance is present, either (a) a single factor does emerge or (b) one general factor will account for a majority of the covariance among the variables. The unrotated principal component analysis reveals that eight distinct factors with eigenvalues greater than 1.0 can be extracted. The (first) largest factor (Eigenvalue 1.95) accounts for 11% of the total variance. Thus, no single factor or general factor is apparent thereby suggesting that common method variance, which might inflate or deflate observed relationships between constructs, is also not a concern.⁸

Another possible concern could be that respondents expressed a personal opinion rather than the view that is held by the firm. In order to avoid such a bias, we explicitly directed the survey to the head of

⁷ Firms were subsequently contacted via phone and by follow-up email. The response rate in our survey is comparable to other online surveys in this industry. We have a particularly high response rate for Germany (25%) that is in line with previous survey studies documenting a higher willingness to respond to surveys in Germany compared to other EU countries (*e.g.*, PatVal-EU, 2005). We specifically test country differences; the only right that demonstrated any significant country difference (stronger for North America) was *Ownership of patents*.

⁸ We used all variables present in Table 3, Model 4.

management or head of business development as described above. In addition, questions were placed in a manner such that respondents first had to answer firm specific questions before they were asked about their firm's internal valuation of ownership rights. From our pretests and conversations with several firms we gained confidence that respondents were answering on behalf of their firm.

Since the purpose of this study is to analyze the *ex ante* valuation of rights, we use a subset of our survey data for which biotechnology firms entered into at least one alliance with a pharmaceutical firm. We know from prior literature that firms cede value (Nicholson *et al.*, 2005) and control rights (Higgins, 2007) when engaging in a first alliance. More importantly, firms that have entered at least one alliance have had to contemplate their valuation for rights in the context of an alliance agreement. By surveying firms that have never engaged in an alliance with a pharmaceutical firm the validity of the responses might be suspect given that they have not been involved in the process of constructing an agreement. The implication of this assumption and the relationship between alliance experience and firms' assessment of rights is discussed more fully in Section 4.3.2. With this focus our sample now includes 157 fully filled out questionnaires for which we had all necessary variables needed to conduct our analysis.

(Table 1 approximately here)

3.3 Variables and factor analysis

3.3.1 Dependent variables

In our survey we asked our respondents about their firm internal valuation for eight ownership rights that were deemed important by our pre-test interviews and which are also consistent with those considered in other studies (*e.g.*, Lerner *et al.*, 2003; Higgins, 2007; Adegbesan and Higgins, 2011). Columns 1-4 in Table 1 define each of these rights and presents their mean level of importance along with their standard deviation for biotechnology firms entering alliances with pharmaceutical partners on a five-point Likert scale ranging from "not important" (1) to "extremely important" (5). A score of three (3) indicates that the biotechnology firm ranked the right to be "important". Rights with values of less than three can

thus be viewed as less important while those rights with a score of greater than three should be viewed as more important.

We learn from observing the data in Table 1 that heterogeneity exists in how biotechnology firms view the importance of ownership rights. While recognized in prior literature, this is the first time, we believe, that this heterogeneity has been demonstrated. An analysis of the means is interesting, for example, the *Ownership of patents* was deemed to have the highest importance (3.9) followed by *Product reversion rights upon termination* (3.6). Not surprisingly, these rights provide strong protections over research projects and intellectual property, which are the primary assets biotechnology firms bring to these partnerships. Surprisingly, *Marketing rights to the product/technology* are ranked third in importance (3.4). While many of the respondent firms lack the necessary capabilities and resources in order to market products, this might suggest these firms, in the longer term, have a desire to expand downstream and market their innovations.

3.3.2 Factor analysis and the bundling of rights

As a result of heterogeneity across firm valuation of rights, can we detect any interrelationship or interdependence between these rights? Given our theoretical interest in the dichotomy between upstream and downstream activities it is important for us to understand the possible relationship between our focal rights. In order to do this we use factor analysis. Factor analysis uses principal component analysis and Varimax rotation. The number of factors extracted was determined by the Kaiser criterion (Eigenvalue > 1) and is consistent with our theoretical framework. Our two factors or bundles of ownership rights are identified in Table 1, Column 5 along with their factor loadings.

We classify the first bundle of four rights as “upstream rights” since they are related to the upstream or research activities of firms (*Ownership of patents*, *Obligation to litigate patent infringement*, *Right to sublicense* and *Product reversion rights upon termination*). These rights increase a biotechnology firm’s flexibility (and outside options) making them less dependent on a specific partner while at the same time protecting their primary asset—their research output. For example, *Ownership of patents* not only

secures formal property rights to a firm's research efforts and is a mechanism to generate revenues through licensing but also allows building upon previous patents in subsequent research efforts. Similarly, the *Right to sublicense* increases a biotechnology firm's ability to generate revenue from others thereby decreasing dependence on one partner. *Product reversion rights upon termination* protect a firm from possible hold-up or shelving and the *Obligation to litigate patent infringement* ensures protection and enforcement of intellectual property rights should infringement occur.⁹ The dynamic capabilities literature highlights a firm's capacity to renew capabilities and shift resources in order to adapt to changes in the environment (Teece *et al.*, 1997). Indisputably, this bundle of rights does in fact increase a firm's capability to adapt and even capitalize on a rapidly changing environment and, in addition, decrease dependence on any one specific alliance partner.

The second set of three rights is bundled together and relates to downstream activities: *Management of clinical trials*, *Control of initial manufacturing*, and *Marketing rights to the product or technology*. At first glance, it does not seem obvious why this pattern or bundle should flow out of biotechnology firm valuations; this type of bundle might be more easily related to a pharmaceutical firm. That said, it is important to note that the majority of our firms are involved in developing therapeutics/vaccines 71%, 43% are developing platform technologies and 22% are involved in diagnostics.¹⁰ On average, our firms already have at least one product on the market. As a result, given our prior discussion in Section 2.2, the breadth of sectors, current activities covered (and future expansion) in these downstream areas, the bundling seems appropriate.

Even though the *Right to publish* was identified in our pre-test interviews as being important, our factor analysis also reveals that it is neither a part of the upstream or downstream factors. One possible explanation for this exclusion from the literature suggests that for firms, publications provide a means of

⁹ Knowles and Higgins (2011) discuss the tensions that exist between partners over some of these rights. For example, while a biotechnology firm may prefer to own the underlying IP, maintain the obligation to litigate patents and/or control IP strategy, these are terms that in-house legal counsel at pharmaceutical firms like to control in order to ensure their downstream investments are secure. Moreover, many biotechnology firms often do not have the financial resources to hire top legal counsel to draft patents or engage in protracted legal disputes, should they occur.

¹⁰ These figures add to more than 100% because some firms cover more than one area.

signaling the possession of tacit knowledge and building the technical reputation that is necessary for exchanging information particularly with academic scientists (Henderson and Cockburn, 1994). If this is the case then it seems reasonable that we do not see it in either of the factors.

Finally, a potential methodological issue arises when utilizing principal component analysis. It assumes continuous, normally distributed variables while our measure for firm valuations of rights are based on Likert scales. As such, we follow the rule of thumb that suggests that scales with four or more points, in fact, approximate the properties of interval scales (Hagedoorn and Heszen, 2009).

3.3.3 Independent variables

Our independent variables that capture information about a biotechnology firm's current and future capabilities are summarized along with bivariate correlations in Table 2. This dual approach comes from prior work (Das and Teng, 1998) that notes that in order to adequately address the drivers or motivations for an alliance, research should not just focus on the capabilities that a firm does not own but should also consider a firm's *current* set of capabilities.

(Table 2 approximately here)

Current R&D capabilities. We measure a biotechnology firm's current R&D capabilities and define a dummy variable, *Upstream capabilities*, which is equal to 1 if a respondent assesses that the firm strongly covers basic research activities internally, 0 otherwise. In science-based industries, firms' upstream activities typically require interacting with universities and public research institutions that conduct basic research. A firm's basic research activities are often a signal for research capacity (Henderson and Cockburn, 1994). In our sample 70% of firms strongly cover basic research.

Downstream capabilities. We measure the extent to which firms are involved in downstream commercialization activities and define a dummy variable, *Downstream capabilities*, which is equal to 1 if a firm strongly covers manufacturing, sales and marketing, 0 otherwise. A dummy variable is used because we are simply interested in distinguishing between those firms with a significance downstream pres-

ence versus those that do not. Only 20% of the firms in our sample are strongly covering these activities. Biotechnology firms are known to enter alliances with pharmaceutical firms in order to access the downstream capabilities needed to transform promising research into marketable products (Rothaermel and Deeds, 2004). These capabilities are often costly to fully develop and maintain and alliances help the firm avoid making investments that may not pay off or for which they cannot keep fully deployed.

Downstream expansion. We proxy the *Downstream expansion* plans of a firm with a standardized index assessed along two dimensions: (i) the extent to which the motivation to enter the alliance was for developing internal marketing/distribution skills; and, (ii) the extent to which the motivation to enter the alliance was to learn from the partner's experience in marketing/distribution.¹¹ This desire to learn and develop is consistent with recent literature (Hsu and Wakeman, 2012). These two motivations are measured on a five point Likert scale ranging from not important (1) to extremely important (5). Firms that rank these items as being highly important are more likely to follow a downstream expansion strategy.

Alliance capability. Alliance capability has been measured several ways in the literature, for example, by the percentage of the management team with a Ph.D. or M.D. (Deeds *et al.*, 1999), by the firms' alliance experience (Hoang and Rothaermel, 2005), or whether the firm had a dedicated individual or team responsible for alliance management (Kale *et al.*, 2002). We define our primary measure of *Alliance capability* as a dummy that equals 1 if a firm commits more than 25% of their total research personnel to alliance projects. This measure has the advantage that it is independent of firm size and abstracts from the intensity of alliances. In our sample, 64% of firms devote at least 25% of their research personnel to alliance projects. Following Kale *et al.* (2002) we also asked firms to identify whether they had a dedicated individual or team that was responsible for the management of alliances. However, this second measure was not significant in any of our specifications. It could be the case that the difference in results with Kale *et al.* (2002) are the result of our focus on the smaller, research intensive partner versus the incumbent (pharmaceutical) firm.

¹¹ With an inter-item correlation that equals 0.42.

3.3.4 Control variables

Alliances to acquire capital. Aghion and Tirole (1994) show that capital constraints can prevent parties from allocating ownership rights efficiently. In line with these theoretical observations, extant empirical work (e.g., Lerner and Merges, 1998; Lerner *et al.*, 2003) finds that external capital constraints lead to more rights being assigned to the financing partner. Unlike these studies, our focus is on gains from trade and we include the extent to which receiving money from alliance partner motivates alliance activity. It may be the case that firms already take into account resource constraints when entering into negotiations. As such, we define a dummy, *Alliances to acquire capital*, which equals 1 if the biotechnology firm considers receiving money as a very important motive for entering an alliance with a pharmaceutical firm, 0 otherwise. Descriptive statistics reveal that capital acquisition is indeed important for firms; almost 80% of firms consider money to be a very important motive for partnering.

Needs access to IP. We consider a second motivation for entering an alliance, in this case, to access IP. We define a dummy variable that equals 1 if the respondent agrees that access to IP is either a very or extremely important motivation for entering an alliance with a pharmaceutical firm, 0 otherwise. Only 30% of our respondents indicated that this was a very or extremely important motivation for entering an alliance. It does suggest, however, that these firms aim to fill their development pipeline with externally acquired technology.

Early stage firm. We consider a firm to be early stage if it has products or technologies under development in the pre-clinical or pre-prototype stage but not in the later stages of the value chain (including clinical trial or prototype development and beyond). *Early stage firm* is a dummy that equals 1 if this criteria was met, 0 otherwise. We assume that earlier stage firms are more resource constrained relative to later stage firms. Twenty percent of the firms in our sample fall into this category. We note that since we are

including diagnostic and platform companies and not just therapeutics, we have broader product information than might be contained in commercial databases.¹²

Firm age. We control for the age of the firm because older firms are likely to have a larger resource and capabilities stock (Rothaermel and Deeds, 2004). Moreover, since many of our sample firms are private, age may also serve as a proxy for firm size. We define *Firm age* as the years since firm's founding date and, on average, our firms are eleven years old.

Alliance experience. The experience garnered from entering more alliances may shape gains from trading rights. As a result we control for the number of alliances each of our firms have entered. We define *Alliance experience* as the natural logarithm of the total number of alliances that the firm has entered prior to the focal alliance, since the variable is skewed to the right.

Sector. We have biotechnology firms that transcend three distinct sectors: therapeutics/vaccines, diagnostics and platform technologies. Of the three sectors, those firms involved in the therapeutic/vaccine market are markedly different in that they experience more expensive, longer and more uncertain development cycles. As such we define a dummy variable, *Therapeutics/vaccines*, if the firm is operating in that sector, 0 otherwise. Seventy-one percent of our firms are developing therapeutics or vaccines.

German firm. Given our disproportionate number of German respondents we create a dummy variable, *German firm*, which equals one if the firm is located in Germany, 0 otherwise. Forty-two percent of the firms in our sample are located in Germany. Even though the extant literature does not indicate country differences in terms of the valuation of or the allocation of ownership rights, being conservative we include this variable to account for potential differences.

4 ANALYSIS AND RESULTS

4.1 Determinants of internal valuation of all rights

¹² For example, the *Pharmaprojects* database could be used to identify therapeutics at various stages but no information would be available for our platform or diagnostic firms.

Our first regressions are reported in Table 3 where we use an ordered logit model to examine how responses to eight ownership rights relate to a set of independent variables. Since our focus is on eight rights each respondent has the opportunity to provide up to eight responses. Recall, each response is a Likert score corresponding to a specific right. Our econometric approach, therefore, is to stack responses for each of our eight rights in order to consider a single econometric model. This process creates a panel where the first firm (respondent) in the sample provides the first eight observations while the second firm provides observations 9 through 16, etc. Since each respondent (biotechnology firm) can appear in the data up to eight times, we use clustered standard errors to account for within firm correlations across the disturbances. Finally, in this first set of regressions we are assuming independence between each of the rights, an assumption we relax below in Section 4.2.

(Table 3 approximately here)

Our results reveal that a firm's current capability stock is correlated with their internal valuation of rights and they appear to vary across different types of capabilities. For example, our measure for R&D capability, *Upstream capabilities*, is positive and significant ($p < 0.05$). This implies that firms that strongly cover upstream activities value rights more highly compared to firms that only partly cover or do not pursue upstream activities. While at first blush this seems logical for the biotechnology firm, these preference structures could cause conflict with a pharmaceutical partner. For example, Knowles and Higgins (2011) discuss the importance for pharmaceutical firms to maintain the right to litigate and control the IP strategy of a project.

Next, we consider the extent to which downstream capabilities are correlated with internal valuation of rights. Across all models in Table 3 *Downstream capabilities* is positively related to the valuation of rights, but it is not significant. However, our measure for whether a firm has plans to expand downstream, *Downstream expansion*, is a strong predictor ($p < 0.01$) of the internal valuation of rights. Firms that expand downstream and enter into alliances in order to learn about downstream capabilities highly value ownership rights and, as such, would not trade them away. Recall that our dependent variable is a stack of

all rights. These two results seem to suggest that firms that have strong downstream capabilities do not highly value a broad set of rights (rather, as we will see below, they more highly value specific rights). In contrast, we know from above that firms that have significant basic R&D capability highly value ownership rights and do not want to trade them away; this carries over into their internal valuations when they decide to downstream expand.

In addition to upstream and downstream capabilities, we also test whether a firm's alliance capabilities (*Alliance capabilities*) are correlated with the valuation of rights. Indeed, across Models 3 and 4 (Table 3) we find that firms with greater alliance capabilities value rights more highly ($p < 0.10$). Presumably, firms with greater alliance capabilities also have a better ability to manage a joint project and deal with unforeseen situations.

Turning to the control variables, our measure that controls for the financial motivation of the biotechnology firm (research-intensive partner), *Alliances to acquire capital*, is negatively but not significantly related to the valuation of rights. Our control for the stage of the underlying research of the firm, *Early stage firm*, is negative and significant ($p < 0.05$). That is, earlier stage firms put a lower value on rights compared to firms in later stages. It may be the case, as we demonstrate below, that the valuation across all rights may be lower however, firms' may highly value a specific subset of rights. Interestingly, we find that *Need access to IP*, is positively and significantly ($p < 0.01$) related to the internal valuation of rights. It appears that the greater a biotechnology firm's interest is in gaining access to IP from the partner, the more rights they want to retain. At first glance this finding is surprising but we will see that once we split the rights into upstream and downstream bundles we gain a more complete explanation for this result.

In order to explore whether firms that already have strong research capabilities and who aim to further strengthen those capabilities through alliances strive for more rights we interact *Upstream capabilities* and *Need access to IP*. Applying this interaction term to Model 4 (Table 3) reveals that the coeffi-

cient is negative, but not significant.¹³ *Firm age* and *Alliance experience* are both unrelated to the valuation of rights. As we will discuss below, this seems to suggest that internal valuation is not developed over time as a firm conducts more deals. Finally, since we had a large number of respondents from Germany we control for country differences, however, the coefficient on *German firm* was not significant in any specification.

4.2 Internal valuation for bundles of rights

While the dependent variable in Table 3 comprised all rights, in Table 4 we present results that are based on the bundles of rights that our factor analysis identified in Section 3.3.2.¹⁴ The five models in the left panel (Table 4a) use *Upstream rights* as a dependent variable while the right panel (Table 4b) uses *Downstream rights* as a dependent variable. Whereas we stacked all eight rights in the econometric model in Table 3, for the dependent variable in Table 4a (*Upstream Rights*) we stack the four rights identified by the factor analysis in Table 1 (*Ownership of patents*, *Obligation to litigate patent infringement*, *Right to sub-license* and *Product reversion right upon termination*). Similarly, in Table 4b we stack the rights identified by the factor analysis in Table 1 (*Management of clinical trials*, *Control of initial manufacturing process*, *Marketing rights to the product/technology*) to form our dependent variable (*Downstream Rights*). As we did for the analyses in Table 3, we again employ an ordered logit model with clustered standard errors.

(Table 4 approximately here)

We find that firms with strong upstream capabilities (*Upstream capabilities*, $p < 0.05$) tend to more highly value upstream rights (Table 4a, Models 1-5) but not downstream rights (Table 4b, Models 1-5). Correspondingly, we find that firms with strong downstream capabilities (*Downstream capabilities*, $p < 0.10$) highly value downstream rights (Table 4b, Models 2-5) but not upstream rights (Table 4a, Models 2-5). The first result is consistent with theory, suggesting that smaller, research intensive (biotechnology)

¹³ The coefficient equaled -0.07 with a standard error 0.09. For brevity, detailed results are not reported in Table 3; however, the results are available from the authors.

¹⁴ With this analysis we now relax the rigid assumption of independence between rights.

firms will specialize in the set of tasks for which they have a comparative advantage and out-license any developments for commercialization (Gans and Stern, 2003). The second result is consistent with Rothaermel and Deeds (2004) who show that often biotechnology firms withdraw from their upstream activities in order to focus on downstream activities; the valuation of rights appears to mirror this decision.

Further, firms planning to expand downstream (*Downstream expansion*) highly value downstream rights ($p < 0.01$). This finding suggests a possible misfit between a firm's current set of capabilities and their internal valuation of rights. Such firms might want to expand downstream in order to increase firm value but by doing so they might also become potential competitors of the former partner (Rothaermel and Deeds, 2004). Moreover, their main motivation for alliances is to learn from their partner. Presumably these partnerships show a higher likelihood of failure as their partners might have differing priors on the long-term objective of the partnership. In addition, if the biotechnology firm retains these rights, although the pharmaceutical firm has to bear a lower investment to perform the associated tasks, the pharmaceutical partner's alliance specific investment to "fit the partnership" (Hart and Moore, 1990: 1123) might be lower compared to a situation in which these rights are allocated to the incumbent.

In our results above (Table 3) we identified a positive relationship between *Alliance capabilities* and valuation of rights. When we bundle rights together, our results suggest that firms with stronger *Alliance capabilities* value upstream-related ownership rights higher ($p < 0.10$). It appears the high internal valuation for all rights (Table 3) was being driven by the high valuation of upstream rights, specifically. Recall, *Alliance capabilities* is defined as the resources a firm commits to a particular alliance. Consistent with our prior explanation, a desire for upstream rights, given a larger commitment of assets might be reflective of a firm's desire to maintain flexibility but it may also reflect their desire to mitigate risk. An additional reason might be that these upstream rights are enforceable in court (Kloyer and Scholderer, 2012).

In terms of our control variables, we find a positive and significant effect of *Need access to IP* on downstream rights. Often firms have already made investments in downstream co-specialized complemen-

tary assets (Chan *et al*, 2007). In this case, firms may seek out other products in order to keep these assets fully deployed but will only do so if they have the appropriate rights in place. Additionally, our results suggest a negative and significant correlation between *Early stage firm* and downstream rights but not with upstream rights. In unreported regressions, we exclude the variable *Upstream capabilities* and *Need access to IP* but the coefficient on *Early stage firm* remained insignificant (Model 1 – Model 5, Table 4a). It appears that *Age* matters for downstream related rights in that older firms pursue more rights, but it does not appear to matter for upstream rights. As in our previous specification, *Alliance experience* has no impact on valuation of rights. *Therapeutic/vaccine* firms tend to value upstream over downstream rights higher than other firms, but the coefficient is significant in only one specification (Model 1, Table 4a). Again, in unreported regressions, we included a dummy variable for firms developing diagnostics; it was not significant nor did it impact the other variables in the model. Finally, we find neither direct country effects nor significant country differences when we interact our main independent variables with country dummies. This is consistent with Reuer and Arino (2007) who also did not find any cross-country effects in their analysis of *ex post* allocations of rights.

4.3 Robustness

4.3.1 Liquidity constraints and internal valuation of rights

To ensure the robustness of our results, we run a number of additional checks. The extant literature (*e.g.*, Lerner *et al*, 2003) suggests that liquidity constraints influence the contractual structure and allocation of rights in alliances. We explore whether these liquidity constraints influence internal valuations of rights. We find that firms that were motivated to enter alliances to acquire capital (*Alliances to acquire capital*), and thus are presumably more cash constrained, do not appear to have a lower (or higher) value for upstream or downstream rights. We interact the variables *Alliances to acquire capital* and *Early stage firm* in order to check whether there is any impact on these particularly cash constrained upstream focused firms; none was found (Model 5, Table 3, and Model 5 in Table 4a and Table 4b). While previous studies point out that liquidity constraints appear to cause loss of rights in the actual negotiation process,

our findings show that these constraints do not appear to have any impact on valuations of rights. In general, this is the pattern we would want to see since it suggests that gains from trading rights are flowing from capabilities and are not being distorted by other factors. It does suggest, however, an important role for the actual negotiation, a topic beyond the scope of this paper but which we discuss below.

4.3.2 Alliance experience and the valuation of rights

We limit our sample to those biotechnology firms that have engaged in at least one alliance. More accurately, our results can thus be viewed as conditional on a firm having entered at least one alliance. This was done, as we discussed above, so we could ensure that firm specific valuation of rights were contemplated within the context of an actual alliance. The question now becomes what role alliance experience plays in the valuation of rights, if any. In specifications presented in Tables 3 and 4, *Alliance experience* was not significantly related to a firm's valuation of all rights (Table 3) or specific bundles of rights (Table 4). While there does not appear to be any significant relationship between the number of alliances and valuations of rights, we next test the difference between those firms that engage in many alliances versus those that engage in few. Results are reported in Table 5.

The split between firms with high and low alliance experience is based on the median number of alliances, *i.e.*, firms with more than two alliances with pharmaceutical firms are categorized as "high alliance experienced". Correspondingly, firms with less than two alliances with pharmaceutical firms are categorized as "low alliance experienced." The only right that is significantly different is *Management of clinical trials*. In this case, biotechnology firms that enter more alliances tend to place a lower valuation for this right. This right is typically related to downstream activities and thus dominated by pharmaceutical firms. Besides this right it does not appear that a biotechnology firm's alliance experience influences their valuation of ownership rights. Ruling out experience as a driver of internal assessment of rights reinforces our findings that they are being formed based on firm capabilities. It remains a possibility, however, that there is a difference between zero and one alliance but that is beyond the scope of this paper. One would need more reliable data about firm valuations for those firms that have never entered an alliance.

(Table 5 approximately here)

4.3.3 Internal valuation or anticipated equilibrium outcome?

A problem could arise with the interpretation of our results if respondents were not expressing firm valuations of rights, i.e. the extent to which they are willing to trade rights, but rather an anticipated equilibrium outcome. If our survey respondents were in fact expressing some type of anticipated outcome then we would expect to see strong correlation between *ex ante* valuations of rights and actual *ex post* allocations. We do not have *ex post* allocation data for our respondents, but we can turn to other studies that have reported such allocations in the biopharmaceutical industry. While this analysis is *ad hoc* we can nevertheless begin to shed some light onto this question. In Table 6 we compare our average *ex ante* valuation of rights with actual *ex post* allocations from Higgins (2007). For our *ex ante* valuation we define a dummy equal to one when the firm considered a particular right to be "very important" or "extremely important". Comparing our *ex ante* internal valuation of rights to actual *ex post* allocation reveals considerable differences thereby suggesting that the respondents were in fact providing internal valuations for rights versus some anticipated equilibrium outcome.

(Table 6 approximately here)

5 DISCUSSION & CONCLUSION

We present a framework where firms should be willing to trade rights to a partner if the partner either has superior capabilities or is better equipped to direct alliance activities (Demsetz, 1988). Our results also suggest that if parties seek rights not aligned with current capabilities then they should be willing to build up those capabilities; having the appropriate rights provides a strong incentive to do so. Furthermore, allocations to the more informed party also serve as a mechanism to reduce information distortions.

Overall, this capabilities perspective takes a less opportunistic view of alliance activity. This less opportunistic view is consistent with Love (2005: 382) who argues that "...contractual issues do not everywhere and always hinge on opportunism *a la* Williamson, and that contracts can have functions beyond

those merely of incentive alignment to prevent wrongdoing.” Besides avoiding opportunism and possible risk of holdup (Anand and Galetovic, 2000), possible functions of contracts (which are often neglected in the theory of the firm) include providing guidance about what to do in the event of uncertainty (Langlois, 1997) or to identify early on potential misunderstandings or “honest disagreements” (Alchian and Woodward, 1988).

This view is supported by the observation that contracts are still used when opportunism is unlikely to be a serious economic threat. In this context, the capabilities perspective adds an intrinsic type of motivation to the extrinsic type so far emphasized in the theory of the firm in which actions of individuals are assumed to be directly related to an incentive-wise encouragement from an external force (*e.g.*, Foss and Klein, 2008). This intrinsic type of motivation expressed in the *voluntarily* alignment of capabilities and contractual structure might be a source of superior alliance performance, which creates a competitive advantage and, ultimately, superior firm performance.

In addition to this framework, we believe we make several other contributions to the literature. Standard theories are based on the notion that there is uniform valuation of ownership rights across firms. We motivate our paper by arguing that firms heterogeneously value the same right, which allows for gains from trade. Utilizing unique survey data, we present empirical evidence on the existence and extent of this differential valuation. Additionally, we are able to uncover and categorize interdependence between rights. This suggests that the assumption of equality and independence of rights are real caveats of previous studies (*e.g.*, Lerner and Merges, 1998; Lerner *et al.*, 2003; Higgins, 2007; Elfenbein and Lerner, 2012; Haeussler and Higgins, 2009), especially those focusing on specific rights (*e.g.*, Lerner and Malmendier, 2010). In general, our findings should signal a cautioning tone for those scholars that seek to examine particular provisions of contracts in isolation.

We split the capabilities that explain the “impact on alliance outcome” (Shan *et al.*, 1994; Rothaermel and Deeds, 2004) into current and future expansion capabilities. The formation of future expansion capabilities, in particular, is also consistent with the incentive systems literature (Gibbons, 2005);

firms are incentivized to build up capabilities when they receive the associated ownership rights. Insofar, we move beyond the static view of current capabilities by taking a firm's desire to expand downstream into account. Firms that indicated a plan to expand downstream also showed a preference for corresponding downstream rights. This suggests, in a broader context, that it is not just capabilities that drive gains from trade but also the intention to build capabilities. It also suggests that these firms want to learn from their partners (Hamel, 1991; Khanna *et al.*, 1998; Rothaermel and Deeds, 2004; Hsu and Wakeman, 2012). Notwithstanding this desire to acquire capabilities and learn, we cautioned that it is possible that capabilities end up being duplicated leading to an increase in costs.

Finally, prior literature stresses the importance of alliance capabilities (Kale and Singh, 2007). We add to this literature by demonstrating that the strength of alliance capabilities positions a firm to efficiently decide about upstream related activities, which in turn, increase their internal valuation for upstream rights. This result complements Kale *et al.* (2002: 765) who find that "...one way of having alliance capability and greater alliance success was to create a dedicated alliance function." While most previous studies on alliance capabilities have focused on their impact on alliance success, we demonstrate that an important intermediate step to take is to consider their influence on contract structure. Coupled together these findings imply that superior alliance performance emanating from alliance capabilities is flowing from a firm's upstream capabilities and decisions. Hence, the value that a capabilities owner can create and appropriate depends not only on the use of the upstream capabilities but also on alliance capabilities, or transaction costs of trading and protecting the associated property rights.

No work is without limitations and ours is no exception. With our survey we gained more detailed knowledge about the biotechnology firm, their motivations and valuations of ownership rights but we lack information about their pharmaceutical partner. This prevents us from considering important issues such as relative bargaining position or relative complementarities between the firms (Adegbesan and Higgins, 2011). In a perfect setting we would want more complete information about the capabilities of all contractual parties. Moreover, in this project we focus on the determinants of gains from trading rights for capa-

bilities. In future research we intend to match firm internal valuation of rights with actual *ex post* allocations. Such an exercise will demonstrate the definitive role of bargaining power and how gains from trading rights for capabilities are related to it.

References

Adegbesan, T., Higgins, M., 2011. Intra-alliance performance, control rights and today's split of tomorrow's value. *Strategic Management Journal* **32**(2), 187-211.

Aghion P, Tirole J., 1994. The management of innovation. *Quarterly Journal of Economics* **109**: 1185-1209.

Alchian, A.A., Woodward, S., 1988. The firm is dead; long live the firm. A review of Oliver E. Williamson's the economic institutions of capitalism. *Journal of Economic Literature* **26**: 65-79.

Anand, B., Khanna, T., 2000. Do firms learn to create value? The case of alliances. *Strategic Management Journal* **21**(3): 295-315.

Anand, B., Gelatovic, A., 2000. Weak property rights and holdup in R&D. *Journal of Economics and Management Strategy* **9**(4): 615-642.

Argyres, N., Mayer, K., 2007. Contract design as a firm capability: An integration of learning and transaction cost perspectives. *Academy of Management Review* **32**(1): 1060-1077.

Armstrong, J.B., Overton, T.S., 1977. Estimating non-response bias in mail surveys. *Journal of Marketing Research* **14**: 396-402.

Arora, A., Ceccagnoli, M., 2006. Patent protection, complementary assets, and firms' incentives for technology licensing. *Management Science* **52**: 292-308.

Arora, A., Fosfuri, A., Gambardella, A., 2001. Markets for technology and their implications for corporate strategy. *Industrial and Corporate Change* **10**(2): 419-451.

Barney J. B. 1991. Firm resources and sustained competitive advantage. *Journal of Management* **17**: 99–120.

Bresnahan, T., Gambardella, A., 1998. *Licensing the market for technology*. in E. Helpman (Ed.), *General Purpose Technologies and Economic Growth*. MIT Press: Cambridge, MA.

Ceccagnoli, M., Graham, S.J., Higgins, M.J., Lee, J., 2010. Firm reliance on external technology in the pharmaceutical industry. *Industrial and Corporate Change* **19**: 839-869.

Chan, T., Nickerson, J., Owan, H., 2007. Strategic management of R&D pipelines with cospecialized investments and technology markets. *Management Science* **53**: 667-682.

Ciccotello, C. S., Hornyak, M. J., 2000. Cooperation via contract: an analysis of research and development agreements. *Journal of Corporate Finance* **6**: 1-24.

Clark, K., Fujimoto, T. 1990. The power of product integrity. *Harvard Business Review* **68**(6): 107-118.

Coase, R., 2006. The conduct of economics: The example of Fisher Body and General Motors. *Journal of Economics and Management Strategy* **15**(2): 255-278.

Cullen, W.C., Dibner, M.D. 1993. Strategic alliances in biotechnology: Imperatives for the 1990s. *Biotechnology Review* **1**: 110-119.

Danneels, E. 2002. The dynamics of product innovation an firm competences. *Strategic Management Journal* **23**: 1095-1121.

Danneels, E. 2008. Organizational antecedents of second-order competences. *Strategic Management Journal* **29**: 519–543.

Das T.K., Teng, B.S., 1998. Between trust and control: Developing confidence in partner cooperation in alliances. *Academy of Management Review* **23**(3): 491-512.

Deeds, D.L., DeCarolis, D.M., Coombs, J.E., 1999. Dynamic capabilities and new product development in high technology ventures: An empirical analysis of new biotechnology firms. *Journal of Business Venturing* **15**: 211-229.

Demsetz, H., 1988. The theory of the firm revisited. *Journal of Law, Economics and Organization*, **4**: 141–161.

Demsetz, H. 1997. *The Economics of the Business Firm: Seven Critical Commentaries*, Cambridge, Cambridge University Press.

Eisenhardt, K.M., Martin, J.A., 2000. Dynamic capabilities: What are they? *Strategic Management Journal* **21**(10-11): 1105-1121.

Elfenbein, D., Lerner, J. 2003. Ownership and control rights in internet portal alliances, 1995-1999. *Rand Journal of Economics* **34**: 356-369.

Elfenbein, D., Lerner, J. 2012. Exclusivity, contingent control rights, and the design of internet portal alliances. *Journal of Law, Economics, and Organization* **28**: 45-67.

Foss, N., 2005. *Strategy and Economic Organization in the Knowledge Economy*. Oxford: Oxford University Press

Foss, N., Klein, P., 2008. The theory of the firm and its critics: A stocktaking and assessment. In: Brousseau, É. (Ed.), *New Institutional Economics: A Guidebook*. Cambridge University Press: Cambridge, p.425-442.

Foss, N., 1996a. Knowledge-based approaches to the theory of the firm: some critical comments, *Organization Science* **7**, 470–476.

Foss, N., 1996b. More critical comments on knowledge-based theories of the firm. *Organization Science* **7**, 519–523.

Gans, J., Hsu, D., Stern, S., 2002. When does start-up innovation spur the gale of creative destruction? *Rand Journal of Economics* **33**: 571–586.

Gans, J., Stern, S., 2000. Incumbency and R&D incentives: Licensing the gale of creative destruction. *Journal of Economics and Management Strategy* **9**(4): 485-51.

Gans, J., Stern, S., 2003. The product market and the market for “ideas”: commercialization strategies for technology entrepreneurs. *Research Policy* **32**(2): 333-350.

Gawer, A., Henderson, R., 2007. Platform owner entry and innovation in complementary markets: Evidence from Intel. *Journal of Economics and Strategy Management* **16**(1): 1-34.

Gibbons, R. 2005. Four formal(izable) theories of the firm? *Journal of Economic Behavior and Organization* **58**: 200-245.

Giovannetti G.T., Morrison, S.W., 2000. *Convergence: The Biotechnology Industry Report*. Ernst & Young: Palo Alto, CA

Haeussler, C., 2011. The determinants of commercialization strategy: Idiosyncrasies in British and German biotechnology. *Entrepreneurship Theory and Practice* **35**(4): 653–681.

Haeussler, C., Patzelt, H., Zahra, S., 2012. Strategic alliances and product development in high technology new firms: The moderating effect of technological capabilities. *Journal of Business Venturing* **27**, 217-233.

Hagedoorn, J., Hesen, G., 2009. Contractual complexity and the cognitive load of R&D alliance contracts. *Journal of Empirical Legal Studies* **6**: 818–847.

Hamel, G., 1991. Competition for competence and inter-partner learning within international strategic alliances. *Strategic Management Journal* **12**: 83-103.

Hamel, G., Y. Doz and C. K. Prahalad (1989). Collaborate with your competitors-and win. *Harvard Business Review* **67**(1): 133-139.

Hart O, Moore J., 1990. Property rights and the nature of the firm. *Journal of Political Economy* **98**(6): 1119-1158.

Helfat, C., Finkelstein, W., Mitchell, W., Peteraf, M.A., Singh, H., Teece, D., Winter, S., 1997. *Dynamic Capabilities: Understanding Strategic Change in Organizations*. Blackwell, Oxford, UK.

- Henderson, R., Cockburn, I., 1994. Measuring competence? Exploring firm effects in pharmaceutical research. *Strategic Management Journal* **15**: 61-83.
- Higgins, M.J., 2007. The allocation of control rights in pharmaceutical alliances. *Journal of Corporate Finance* **13**: 58-75.
- Higgins, M., Rodriguez, D., 2006. The outsourcing of R&D through acquisitions in the pharmaceutical industry. *Journal of Financial Economics* **80**: 351-383
- Hoang, H., Rothaermel, F.T., 2005. The effect of general and partner-specific alliance experience on joint R&D project performance. *Academy of Management Journal* **48**(2): 332-345.
- Hsu, D., Wakeman, S., 2012. Cost and benefits of learning through alliances for entrepreneurial firms. European School of Management and Technology Working Paper No. 11-02(R2).
- Inkpen, A.C., Crossan, M.M., 1995. Believing is seeing: Joint Ventures and organization learning. *Journal of Management Studies* **32**(5): 595-617.
- Kale, P., Dyer, J., Singh, H., 2002. Alliance capability, stock market response and long-term alliance success: The role of the alliance function. *Strategic Management Journal* **23**: 747-770.
- Khanna, T., 1996. Winner-take-all alliances. Harvard Business School working paper, No. 96-033.
- Khanna, T., Gulati, R., Nohria, N., 1998. The dynamics of learning alliances: Competition, cooperation and relative scope. *Strategic Management Journal* **19**: 193-210.
- Kloyer, M., Scholderer, J., 2012. Effective incomplete contracts and milestones in market-distant R&D collaboration. *Research Policy* **41**: 346-357.
- Kloyer, M., 2011. Effective control rights in vertical R&D collaboration. *Managerial and Decision Economics* **32**: 457-468.
- Knowles, S., Higgins, M.J., 2011. Vertical disintegration in the pharmaceutical industry and the role of IP. *Intellectual Asset Management* **45**: 10-15.

Kogut, B., Zander, U., 1996. What do firms do? Coordination, identity and learning. *Organization Science* **7**: 502-518.

Kogut, B., Zander, U., 1992. Knowledge of the firm, combinative capabilities, and the replication of Technology. *Organization Science* **3**: 383-397.

Koza M.P., Lewin, A.Y., 1998. The co-evolution of strategic alliances. *Organization Science* **9**: 255–264.

Krieger, D., Ruback, R.S., 2001. Merck and company: Evaluating a drug licensing opportunity. Case 9-201-023. Harvard Business School, Cambridge, MA.

Langlois, R., 1992. Transaction cost economics in real time. *Industrial and Corporate Change* **1**: 99-127.

Lerner, J., Malmendier, U., 2010. Contractibility and contract design in strategic alliances. *American Economic Review* **100**(1): 214-246.

Lerner J., Merges, R.P., 1998. The control of technology alliances: An empirical analysis of the biotechnology industry. *Journal of Industrial Economics* **46**(2): 125-156.

Lerner J., Shane H., Tsai, A., 2003. Do equity financing cycles matter? Evidence from biotechnology alliances. *Journal of Financial Economics* **67**: 411-446

Levinthal, D.A., March, J.G., 1993. The myopia of learning. *Strategic Management Journal* **14**: 95-112.

Love, J.H., 2005. On the opportunism-independent theory of the firm. *Cambridge Journal of Economics* **29**: 381–397.

Manne, H., 1965. Mergers and the market for corporate control. *Journal of Political Economy* **73**: 110-120.

March, J. G., 1991. Exploration and exploitation in organizational learning. *Organization Science* **2**(1): 71-87.

Mody, A., 1993. Learning through alliances. *Journal of Economic Behavior Organization* **20**(2): 151-170.

- Mowery, D.C., Oxley, J.E., Silverman, B.S., 1996. Strategic alliances and interfirm knowledge transfer. *Strategic Management Journal* **17**: 77-91
- Nicholson, S., Danzon, P., McCulloch, J., 2005. Biotech-pharmaceutical alliances as a signal of asset and firm quality. *Journal of Business* 78(4): 1433-1464.
- Parkhe, A., 1993. Strategic alliance structuring: a game theoretic and transaction cost examination of inter-firm cooperation. *Academy of Management Journal* **36**(4): 794-829.
- PatVal-EU, 2005. The value of the European patents: Evidence from a survey of European inventors. Final report of the PatVal-EU Project, DG Science & Technology, European Commission. Brussels.
- Peteraf, M.A., 1993. The cornerstones of competitive advantage: a resource-based view. *Strategic Management Journal* **14**(3): 179-191.
- Pisano, G., 1990. The R&D boundaries of the firm: an empirical analysis. *Administrative Science Quarterly* **35**: 153-176.
- Podsakoff, P.M., Organ, D.W., 1986. Self-reports in organizational research: Problems and prospects: *Journal of Management* **12**(4): 531-544.
- Powell, W., Brantley, P., 1992. *Competitive cooperation in biotechnology: Learning through networks?* In N. Nohria and R. Eccles (Eds.), *Networks and Organizations: Structure, Form and Action*. Harvard Business School Press, Boston, MA, pp. 365-394.
- Reuer, J., Arino, A., 2007. Strategic alliance contracts: Dimensions and determinants of contractual complexity. *Strategic Management Journal* **28**: 313-330.
- Richardson, G.B., 1972. The organization of industry. *Economic Journal* **82**: 883-896.
- Rothaermel, F., Deeds, D., 2004. Exploration and exploitation alliances in biotechnology: A system of new product development. *Strategic Management Journal* **25**: 201-221
- Schilke, O., Goerzen, A., 2010. Alliance management capability: An investigation of the construct and its measurement. *Journal of Management* **36** (5): 1192-1219.

Serrano, C.J., 2011. Estimating the gains from trade in the market for innovation: Evidence from the transfer of patents. *NBER Working Paper* #17304.

Shan, W., 1990. An empirical analysis of organizational strategies by entrepreneurial high-technology firms. *Strategic Management Journal* **11**(2): 129-139.

Shan, W., Walker, G., Kogut, B., 1994. Interfirm cooperation and startup innovation in the biotechnology industry. *Strategic Management Journal* **15**: 387–394.

Teece, D., 1986. Profiting from technological innovation. *Research Policy* **15**(6): 285-305.

Teece, D., Pisano, G., Shuen, A. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal* **18**: 509-533.

Wernerfelt, B., 1984. A resource-based theory of the firm. *Strategic Management Journal* **5**(2): 171–180.

Williamson, O., 1985. *The Economic Institutions of Capitalism*. New York: Free Press.

Table 1. Description of Ownership Rights and Factor Loadings

Ownership rights	Descriptives			Factor analysis (Factor loading)	
	No.obs	Mean	Std.Dev.	Upstream Bundle	Downstream Bundle
Ownership of patents	157	3.90	1.01	<u>0.78</u>	0.16
Obligation to litigate patent infringement	152	3.33	1.01	<u>0.67</u>	0.11
Right to sub-license	156	3.32	1.12	<u>0.78</u>	0.06
Product reversion rights upon termination	148	3.63	1.21	<u>0.63</u>	0.32
Right to publish	156	2.74	1.07	0.35	0.27
Management of clinical trials	147	2.93	1.21	0.18	<u>0.77</u>
Control of initial manufacturing process	152	2.80	1.28	0.08	<u>0.84</u>
Marketing rights to the product/technology	157	3.35	1.18	0.25	<u>0.75</u>

Note: Kaiser-Meyer-Olkin:0.78

Table 2. Summary Statistics and Correlations

Variable	Obs	Mean	Std. Dev.	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Upstream capabilities	157	0.701		0	1	1									
(2) Downstream capabilities	157	0.197		0	1	-0.200	1								
(3) Downstream expansion	157	-0.007	0.855	-1.41	1.70	-0.023	-0.003	1							
(4) Alliance capabilities	157	0.643		0	1	0.181	-0.265	-0.054	1						
(5) Alliances to acquire capital	157	0.790		0	1	0.004	-0.215	0.129	0.171	1					
(6) Need access to IP	157	0.299		0	1	-0.180	-0.045	-0.050	0.051	-0.038	1				
(7) Early stage firm	157	0.197		0	1	0.150	-0.125	-0.087	0.136	-0.019	-0.185	1			
(8) Age	157	11.000	8.619	2	85	0.008	0.129	-0.041	-0.187	-0.124	0.123	-0.160	1		
(9) Alliance experience	157	10.242	22.102	0	235	-0.150	0.138	-0.120	-0.067	0.003	0.038	-0.102	0.066	1	
(10) Therapeutics	157	0.707		0	1	0.129	-0.384	0.133	0.047	0.114	0.146	-0.032	0.090	-0.163	1
(11) Germany	157	0.420		0	1	-0.176	0.096	0.026	-0.039	-0.067	0.007	-0.001	-0.051	0.086	-0.161

Table 3. Ordered Logit Results – All Rights

Variables	All Control rights				
	Model 1	Model 2	Model 3	Model 4	Model 5
Upstream capabilities	0.426** (0.199)	0.444** (0.193)	0.462** (0.186)	0.415** (0.185)	0.418** (0.186)
Downstream capabilities		0.194 (0.203)	0.157 (0.204)	0.216 (0.200)	0.206 (0.202)
Downstream expansion			0.385*** (0.114)	0.394*** (0.115)	0.393*** (0.114)
Alliance capabilities				0.305* (0.175)	0.307* (0.174)
Alliances to acquire capital * Early stage firm					-0.336 (0.487)
Alliances to acquire capital	-0.0204 (0.179)	0.006 (0.176)	-0.082 (0.189)	-0.125 (0.197)	-0.055 (0.216)
Need access to IP	0.414** (0.185)	0.421** (0.182)	0.514*** (0.183)	0.484*** (0.183)	0.498*** (0.187)
Early stage firm	-0.581** (0.247)	-0.564** (0.248)	-0.492** (0.234)	-0.529** (0.232)	-0.267 (0.407)
Age	0.01 -0.008	0.01 -0.008	0.01 -0.008	0.013 -0.008	0.013 -0.008
Alliance experience (ln_alliances)	-0.0679 -0.091	-0.0674 -0.091	-0.0514 -0.087	-0.0645 -0.085	-0.0635 -0.085
Therapeutic/vaccine	0.317 (0.213)	0.378 (0.233)	0.289 (0.225)	0.295 (0.225)	0.280 (0.228)
Germany	-0.123 (0.172)	-0.125 (0.171)	-0.168 (0.166)	-0.161 (0.166)	-0.157 (0.166)
Observations	1,225	1,225	1,225	1,225	1,225
R squared	0.052	0.052	0.062	0.063	0.064
Chi2	206.8	209.0	230.7	234.0	233.4
Robust standard errors in parentheses					
*** p<0.01, ** p<0.05, * p<0.1					

Table 4: Ordered Logit Results - Upstream and Downstream Rights

Variables	Table 4a: Upstream Rights					Table 4b Downstream Rights				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5
Upstream capabilities	0.526** (0.227)	0.511** (0.223)	0.528** (0.222)	0.466** (0.219)	0.476** (0.221)	0.335 (0.283)	0.381 (0.277)	0.395 (0.269)	0.379 (0.277)	0.380 (0.277)
Downstream capabilities		-0.180 (0.248)	-0.210 (0.252)	-0.140 (0.248)	-0.160 (0.250)		0.509* (0.277)	0.476* (0.274)	0.495* (0.274)	0.491* (0.276)
Downstream expansion			0.264* (0.138)	0.279** (0.139)	0.278** (0.137)			0.534*** (0.160)	0.536*** (0.159)	0.535*** (0.159)
Alliance capabilities				0.405* (0.216)	0.416** (0.212)				0.0999 (0.263)	0.100 (0.262)
Alliances to acquire capital * Early stage firm					-0.747 (0.716)					-0.102 (0.676)
Alliances to acquire capital	0.0741 (0.258)	0.0477 (0.261)	-0.000720 (0.270)	-0.0536 (0.277)	0.104 (0.291)	-0.116 (0.247)	-0.0578 (0.244)	-0.212 (0.262)	-0.229 (0.274)	-0.206 (0.310)
Need access to IP	0.110 (0.208)	0.103 (0.209)	0.159 (0.211)	0.120 (0.213)	0.151 (0.215)	0.862*** (0.275)	0.880*** (0.273)	1.020*** (0.281)	1.009*** (0.285)	1.014*** (0.290)
Early stage firm	-0.407 (0.323)	-0.423 (0.318)	-0.385 (0.311)	-0.419 (0.311)	0.158 (0.619)	-0.770** (0.305)	-0.713** (0.311)	-0.585** (0.296)	-0.600** (0.301)	-0.520 (0.589)
Age	0.00658 (0.00935)	0.00751 (0.00953)	0.00905 (0.00969)	0.0128 (0.0103)	0.0145 (0.0104)	0.0232** (0.0104)	0.0214** (0.0104)	0.0211** (0.0104)	0.0220** (0.0107)	0.0223** (0.0108)
Alliance experience (ln_alliances)	-0.00680 (0.113)	-0.00762 (0.113)	0.00278 (0.111)	-0.0105 (0.108)	-0.00944 (0.110)	-0.108 (0.111)	-0.104 (0.110)	-0.0789 (0.105)	-0.0834 (0.107)	-0.0833 (0.107)
Therapeutic/vaccine	0.519* (0.265)	0.463 (0.291)	0.385 (0.294)	0.397 (0.296)	0.371 (0.294)	0.192 (0.296)	0.359 (0.319)	0.282 (0.300)	0.281 (0.302)	0.275 (0.309)
Germany	-0.272 (0.221)	-0.268 (0.221)	-0.297 (0.219)	-0.284 (0.221)	-0.271 (0.222)	0.065 (0.232)	0.065 (0.231)	-0.008 (0.228)	-0.007 (0.228)	-0.006 (0.229)
Question Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	613	613	613	613	613	456	456	456	456	456
R squared	0.0366	0.0370	0.0417	0.0451	0.0466	0.0483	0.0516	0.0691	0.0693	0.0693
Chi2	83.92	83.70	85.55	85.25	82.91	54.84	56.22	62.43	63.64	63.82

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Summary Statistics for Ownership Rights: High and Low Alliance Experienced Firms

Ownership rights	High alliance experienced firms			Low alliance experienced firms			Diff.mean
	No.obs	Mean	Std.Dev.	No.obs	Mean	Std.Dev.	p-value
Ownership of patents	55	3.93	1.07	91	3.90	0.96	0.73
Obligation to litigate patent infringement	54	3.37	1.09	87	3.38	0.94	0.90
Right to sub-license	55	3.36	1.24	90	3.33	1.03	0.64
Product reversion right upon termination	53	3.74	1.32	84	3.62	1.10	0.33
Right to publish	55	2.69	1.10	90	2.79	1.08	0.58
Management of clinical trials	49	2.65	1.13	87	3.08	1.23	0.04
Control of initial manufacturing process	51	2.67	1.34	90	2.91	1.24	0.26
Marketing rights to the product/technology	53	3.25	1.31	93	3.42	1.09	0.54

Note: The split between high and low alliance experienced firms are based on the median of number of alliances, *i.e.*, firms with more than two alliances with pharmaceutical firms are categorized as high alliance experienced. Correspondingly, firms with less than 2 alliances with pharmaceutical firms fell in the low alliance experience category.

Table 6: *Ex Ante* Preference for Ownership Rights versus *Ex Post* Allocation

	<i>Ex ante</i> valuation of rights	<i>Ex post</i> allocation (Higgins, 2007)	Difference
Ownership rights			
Ownership of patents	64%	82%	18%
Obligation to litigate patent infringement	43%	42%	-1%
Right to sub-license	47%	29%	-18%
Product reversion rights upon termination	61%	18%	-43%
Right to publish	26%	28%	2%
Management of clinical trials	35%	20%	-15%
Control of initial manufacturing process	33%	33%	0%
Marketing rights to the product/technology	49%	78%	29%

Note: The *ex post* actual allocation is based on the dataset used in Higgins (2007). The dataset uses information on 165 alliance contracts from Deloitte Recap between biotechnology and pharmaceutical firms.