Beyond Contracts:

Governing Structures in Non-Equity Alliances

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ABSTRACT

Non-equity alliances are often portrayed in the literature as purely contractual collaborative agreements. This paper questions the notion that contractual safeguards and incentives alone provide the formal governance mechanisms that undergird non-equity alliances. We argue and show that partners craft elaborate committee structures that serve as administrative interfaces for collaborative agreements. These committee structures have well-defined authority relationships and oversight responsibilities and exhibit several key characteristics of hierarchy. We demonstrate that monitoring needs arising from moral hazard and knowledge misappropriation risk, as well as coordination needs arising from increased partner interdependence, are key determinants of such administrative mechanisms in the governance of non-equity alliances.

INTRODUCTION

Alliances have become an important means by which firms, particularly in high-tech sectors, access new skills and complementary resources required to develop and commercialize innovations (Anand *et al.*, 2010; Diestre and Rajagopalan, forthcoming; Rothaermel and Boeker, 2008). The structuring decisions that follow the choice of alliance as an organizational form can shape how firms interact, link resources and achieve intended performance outcomes (Aggarwal *et al.*, 2011; Mjoen and Tallman, 1997). For example, in analyzing the structuring of alliances, scholars have often focused on firms' choices between discrete governance structures, bifurcating the governance continuum between markets and hierarchies into non-equity and equity alliances, suggesting that the latter afford greater monitoring through a joint board and enhanced incentive alignment through ownership sharing (Contractor *et al.*, 2011; Li *et al.*, 2011; Pisano, 1989). More recently, alliance governance research has delved more deeply into alliance design by investigating alliance structures in more fine-grained terms. In particular, there has been increased interest in the design of formal governance mechanisms, especially contracts, and their potential interaction with relational governance mechanisms (Gong e*t al.*, 2007; Gulati and Nickerson, 2008; Hoetker and Mellewigt, 2009; Luo, 2002; Mesquita *et al.*, 2008; Poppo and Zenger, 2002).

Non-equity alliances have therefore been conceived as hybrids that are more market-like than other collaborative agreements, so they have been investigated as contractual agreements, with particular attention focused on firms' specification of contractual clauses and safeguards. For instance, research has characterized the complexity of alliance contracts, with focus given to the detail with which technical clauses, legal clauses, and contingencies are specified in the contract (Argyres *et al.*, 2007; Hagedoorn and Hesen, 2007; Lumineau and Malhotra, 2011;

Parkhe, 1993; Reuer and Arino, 2007; Ryall and Sampson, 2009). This aspect of alliance design is important because the contract captures the concerns of the partners at the contracting stage and enables them to sanction behaviors, specify duties and incentives, and allocate decision rights. At the same time, gaps in contracts are inevitable given the uncertain contexts in which alliances are formed, the intangible resources subject to exchange, and the costs of contracting (Elfenbein and Lerner, 2003). Because contractual incompleteness in turn limits the ability of contracts to efficiently address the *ex post* adaptation needs of collaborators (Bajari and Tadelis, 2001; Januszewski Forbes and Lederman, 2009), partners may craft administrative structures that provide a forum to mutually adapt to contingencies, monitor and coordinate activities, and resolve disputes that emerge. While non-equity alliances might lack some of the hierarchical controls and *ex post* governance mechanisms afforded by joint ventures, we will show that they do have administrative structures in place to address such *ex post* governance concerns and facilitate coordination. Prior research has not attended to this aspect of the governance of non-equity alliances, however, given the emphasis placed on discrete governance structures (e.g., the equity/non-equity dichotomy) and the more recent focus on collaborative agreements' contractual supports.

In this paper, we characterize the administrative structures underlying non-equity alliances and examine some of their key antecedents. Specifically, we address two research questions. First, to what extent do elements of hierarchy feature in the design of non-equity alliances? Second, how do specific transactional attributes of non-equity collaborations affect the usage of these hierarchical elements? As we will discuss in detail below, by hierarchical elements we refer to the administrative committees that have decision-making authority delegated to them regarding various aspects of collaboration or have oversight responsibilities over various

subcommittees that are set up to carry out well-defined functions. Although prior research has acknowledged the existence of such administrative committees in non-equity alliances, their structure and governance functions have not been subject to detailed analysis (e.g., Lerner and Merges, 1998; Reuer *et al.*, 2002; Robinson and Stuart, 2007). Partners may jointly participate on such committees and contractually establish their procedures for decision-making, so these committees resemble boards-like structures with clearly delineated authority over collaborative activities (Smith, 2005).

Prior alliance research has noted that administrative structure in equity alliances (e.g., boards in joint ventures) perform two main functions: monitoring and coordination (Gulati and Singh, 1998). Such structures enable better *ex post* monitoring of partner actions to mitigate risks of opportunistic behavior such as knowledge misappropriation as well as facilitate information flows necessary for coordinating activities (Kumar and Seth, 1998). In this paper, one of our main objectives is to examine the antecedents of related administrative mechanisms in non-equity alliances. To this end, our theory associates firms' usage of various administrative structures in non-equity alliances with their monitoring and coordination needs. Specifically, we develop arguments that monitoring concerns originating in the size and complexity of the alliance and potential misappropriation of knowledge are associated with greater hierarchy and *ex post* governance mechanisms in non-equity alliances. We also build on Thompson (1967) and prior applications to alliance governance (Gulati and Singh, 1998) to argue that the interdependence of partner activities and the corresponding need for coordination contribute to more elaborate administrative mechanisms in non-equity alliances.

We test our ideas in the context of alliances in the biotechnology industry and use hand-collected data from contracts on non-equity alliances' administrative committees. The

biotechnology research context enables us to focus on monitoring and coordination concerns because partners need to employ proprietary knowledge and skills, as well as link complementary resources across multiple functions to successfully commercialize new products (Diestre and Rajagopalan, forthcoming; Rothaermel and Deeds, 2004). We obtain information about the type, size, and number of administrative committees as well as their authority relationships, and this enables us to investigate the degree to which hierarchy is manifest in non-equity collaborations.

This paper advances alliance governance research by revealing several interesting features of non-equity alliances that have not been investigated in previous studies. First, by uncovering the different types of committee structures that partners design, our study sheds light on the complex hierarchical elements embedded in many non-equity alliances. Previous research on formal governance mechanisms supporting non-equity alliances suggests that unilateral and bilateral non-equity alliances differ in their incentive alignment potential (Oxley, 1997), so by investigating hierarchical elements in non-equity alliances our study adds another dimension of formal governance as another important source of heterogeneity in these collaborative agreements. Second, this study brings into focus *ex post* adaptation needs in non-equity alliances and their implications for the design of specific governance features of these alliances. We extend recent research on alliance contracts by investigating administrative structures as a neglected facet of formal governance in collaborative agreements. Finally, this study complements prior research that focuses on the allocation of control rights in alliances (e.g., Lerner and Merges, 1998) by identifying administrative committees as the key administrative instruments through which the control rights allocated to parties are exercised during the implementation of collaborations.

THEORETICAL BACKGROUND

Partners entering into an alliance can choose from a broad range of potential governance structures to achieve control and coordination (e.g., minority equity partnerships, greenfield joint ventures, partial acquisitions, R&D agreements, etc.). In order to capture the essential governance features of these various organizational forms in a parsimonious typology, alliance research has often used the two broad categories of equity and non-equity alliances (e.g., Pisano, 1989). This parsimonious classification scheme is based in part on the logic of transaction cost economics, which characterizes governance structures along the dimensions of incentive intensity and administrative control mechanisms (Williamson, 1985; Williamson, 1991). Accordingly, equity alliances are portrayed as being more hierarchical than non-equity alliances because they provide strong administrative control while preserving and aligning incentives. Non-equity alliances are viewed as being governed chiefly by a contract between partners, but there can still be heterogeneity in incentive alignment based on the design of the contract and partners' respective payoffs (e.g., Parkhe, 1993).

Partners in a non-equity alliance can also employ other governance mechanisms to support their collaboration, including the allocation of particular decision rights or the specification of particular reporting and auditing requirements. More importantly, partners can also establish administrative structures that are often presumed to be available only to equity alliances. For example, partners can set up board-like structures that control and coordinate the activities of the alliance (Smith, 2005). The contract may serve as a reference point for administering the alliance by stipulating the design, functions and performance of these board-like structures (Hart and Moore, 2008). Because alliances are based on an incomplete contract between organizations, such administrative structures perform the important function of filling in

gaps that exist in the contract. Therefore, these structures can help not only in reducing contracting costs by reducing the need to account for possible contingencies, but they can also promote efficiency *ex post* by facilitating monitoring and mutual adjustment.

Committees operate at the interface of partnering firms and perform several important functions to monitor and coordinate alliance activities (Deck and Strom, 2002). Partners can assign resource allocation decisions these committees (Laroia and Krishnan, 2005) as well as explicitly delineate the purview of their authority in the contract. By nominating representatives with adequate authority in the respective organizations and specifying decision-making rules (e.g., voting), partners can also ensure required levels of coordination, similar to the design of departments in unitary organizations (Jones, 2007). In addition, partners can also entrust the committees with managing and monitoring information exchanges and coordination routines (de Man *et al.*, 2010). Consultants and managers have suggested that setting up joint steering committees and other functional committees are important to the effective management of alliances in many industries, including chemicals, pharmaceuticals, electronics, and airlines (Jones, 2007; de Man *et al.*, 2010). Practitioners have also provided guidelines on ways partners might establish and structure these committees (e.g., Laroia and Krishnan, 2005).

Several academic studies from economics, law and management have also observed such committees in samples of alliances or have mentioned their potential roles in various high tech collaborative agreements. For example, Reuer *et al.* (2002) reported that forty-five percent of alliances in their sample of biotechnology agreements had some type of coordination committee at the formation of the alliance. Scholars have also suggested that committees provide roles such as coordination, information sharing, and monitoring in alliances (Kale and Singh, 2009; Robinson and Stuart, 2007). As another illustration, committees can coordinate decisions on

technical specifications and marketing activities in multipartner and standard setting alliances (Lavie *et al.*, 2007; Leiponen, 2008). They might also facilitate exit from an alliance without a breach of contract (Smith, 2005). While only suggestive, these studies indicate that committees might serve as an important dimension of formal governance in non-equity alliances.

To illustrate the potential relevance and roles of committees in non-equity alliances, we also consulted several biotechnology alliance contracts. For example, in an agreement between Pfizer and Neurocrine Biosciences, the following two excerpts concern administrative committees featuring in the design of the alliance: (1) "In order to fulfill the objectives of this agreement, the parties agree to establish a Steering Committee, a Joint Operating Committee, a Marketing Committee, a Development Committee, a Regulatory Committee and a Supply Committee." (2) "The Steering Committee shall address all of the significant and strategic issues within the purview of various Committees, and shall be responsible for resolving any issues referred by the Joint Operating Committee. The Steering Committee will be presented with updates on activities and achievements of the Committees and otherwise as provided below." These excerpts indicate the broad range of functional committees that partners might employ to coordinate their activities, and they also indicate that steering committees oversee these functional committees. Typically, the mandates of the steering committee include setting the objectives of an alliance; approving plans for development, commercialization and marketing; and establishing any new subcommittees as required.

The following excerpts from the alliance contract between Alnylam Pharmaceuticals and Cubist Pharmaceuticals provide additional insights into specific functions of the steering committee and its relationship with the functional subcommittees: (1) "Manage and oversee the development and Promotion of the Product in the Territory pursuant to the terms of this

Agreement." (2) "Review and make recommendations for revisions of any material amendments to the Promotion Plan within thirty (30) days after receipt thereof." (3) "Review the progress of the Development Committee and the Marketing Committee." (4) "…Resolve disputes, disagreements and deadlocks unresolved by the Development Committee and the Marketing Committee." and (5) "Review any development activities following FDA Approval, including responsibility for approving any Additional Development requested by either Party..." The excerpts indicate that monitoring and review of activities of the alliance are the main functions of the steering committee. In addition, the steering committee also serves as a first step for resolving disputes between partners. It is therefore clear that that the steering committee is at the apex of the administrative structures within the alliance created to manage the collaboration.

As these examples also illustrate, partners specify several functional committees that are responsible for particular value chain activities (e.g., research, development and commercialization, etc.) or for general functions such as finance or a patent committee for coordinating intellectual property related activities. The general responsibility of these committees is to coordinate and manage information flows, and the specific responsibilities vary depending on the function involved. Development committees are typically responsible for crafting and updating the development plan for products and may also coordinate regulatory approvals if no specialized regulatory committee exists. Commercialization committees are responsible for formulating and updating commercialization plans for the alliance's products. Patent committees may be responsible for the maintenance, defense and enforcement of intellectual property developed by the alliance.

The roles of functional subcommittees and their relationship to steering committees also suggest that it is possible to compare non-equity alliances based on the extent to which

hierarchy-like features are incorporated in the committee structures designed to govern the alliance. Specifically, the design of committee structures is analogous to the hierarchical design of organizations as layers of subordinate units (Garicano, 2000; Simon, 1957). Accordingly, the division of authority between different types of committees can be used to measure the degree of hierarchy in non-equity alliances, as we describe below. This in turn allows us to match the choice of committee structures with transaction characteristics following the discriminating alignment logic of TCE and the coordination needs of collaborative agreements. We build on this logic to characterize the committee structures that partners agree to set up for managing the alliance. In the following section we identify some of the challenges that lead partners to choose different committee structures in governing non-equity alliances.

HYPOTHESES DEVELOPMENT

Following the discriminating alignment hypothesis, complex alliance transactions require complex governance structures that enable monitoring for opportunism and adjustment to unanticipated contingencies (Williamson, 1991). Alliance partners also need to coordinate resources between them. Accordingly, alliance research has emphasized three main considerations driving an alliance's governance needs: the potential for moral hazard, appropriation of knowledge, and coordination of activities across firm boundaries (Gulati and Singh, 1998; Pisano, 1989). Information asymmetry between partners and the attendant risk of opportunistic behavior in the form of shirking, effort misallocation or knowledge appropriation increase the need for monitoring in alliances. The interdependence of partner activities and the attendant need to decompose and synchronize tasks lead to significant coordination challenges (e.g., Casciaro, 2003; Hoetker and Mellewigt, 2009; Mesquita and Brush, 2008). Scholars have therefore argued that introducing hierarchical controls is an important means to address such

monitoring and coordination challenges. We build on this research to identify the antecedents to the choice of committee structures in non-equity alliances. Specifically, we identify the benefits of monitoring in complex organizational forms, regulating access as a means to mitigate expropriation, and improving efficiency of information processing as the main mechanisms through which hierarchical administrative structures enable partners to overcome monitoring and coordination concerns.

Before specifying research hypotheses, we first clarify the meaning of hierarchical administrative structures in our analysis. The general meaning of hierarchy is that of a system in which an authority relationship subordinates the constituent elements to the system (Simon, 1962). Consistent with this meaning, Radner (1992) defines hierarchy as a ranked tree where a source of all formal authority exists and such formal authority determines the rank of any element. In the context of this paper, the various committees and subcommittees partners set up to govern the alliance constitute the ranked tree-like structure. The committee that determines and adjudicates actions of individuals or all other committees so far as the alliance is concerned becomes the root of the authority relationship within the collaboration (Barnard, 1938). Accordingly, we characterize the hierarchical nature of the administrative structure in an alliance by the existence of a root for all formal authority, and the number of distinct ranks (or layers of authority) that constitute the committee structure. For the sake of brevity and clarity in stating the hypotheses, we use the term "hierarchical administrative mechanisms" within a non-equity alliance, and in the empirical analyses we separately analyze the presence and size of steering committees, as well as the degree of hierarchy in the committee structures.

Technology Overlap

An important source of monitoring concerns, particularly for high tech collaborations, and has received significant research attention is the need to protect proprietary knowledge, skills and technologies from being exposed to partners (e.g., Hamel *et al.*, 1989; Li *et al.*, 2008). Although partners benefit from access to complementary resources, overlapping domains of technological expertise also increase the threat of partners absorbing and opportunistically exploiting proprietary knowledge (Dushnitsky and Lenox, 2005; Katila *et al.*, 2008). Therefore, partners need adequate monitoring to ensure that they enjoy the benefits of collaboration while mitigating the risk of knowledge leakage to partners.

Unintended knowledge transfers in alliances can occur through several means. First, because collaborative activities involve communication and sharing of information, loss of proprietary information can occur via knowledge codified in documents, blueprints, test/trials data or internal memos (Appleyard, 1996). Second, partners may expose tacit know-how and routines through the interaction and movement of personnel, and such problems also become more severe when firms have overlapping domains of technological expertise (Oxley and Sampson, 2004). Third, partners may gain information about key employees and induce them to switch employers to benefit from their inalienable human capital. Appropriation of critical resources such as ideas and individuals can be minimized by the exercise of authority and implementing hierarchical controls to regulate access to such resources (Garcia-Canal *et al.*, 2008; Rajan and Zingales, 1998).

Committee structures can replicate elements of hierarchical control in non-equity alliances to safeguard against unintended knowledge leakage for several reasons. As discussed earlier, a steering committee can serve as centralized point of contact through which critical

information is routed and documents are exchanged. By forcing critical interactions among partners to pass through the steering committee, unstructured communications between partners are reduced. Moreover, because the steering committee can monitor the deployment and movement of personnel, it can better control informal learning through unintended interactions among employees (Oxley and Wada, 2009). The steering committee can be vested with the authority to design tasks and assign roles so as to minimize deep exposure of routines. By creating a horizontal hierarchy of committees of specialized tasks partners can contain access to the broader knowledge base. Finally, if knowledge losses are detected, the steering committee has the authority to make changes to the alliance, including the allocation of tasks and the implementation of new functional subcommittees. Of course, partners might build incentives into alliance agreements to reduce the threat of knowledge misappropriation, but the effectiveness of such incentives can be limited since the partners remain independent organizations. Likewise, other contractual safeguards appear in alliance contracts that can address knowledge misappropriation, but the incompleteness of contracts also indicates the value of using hierarchical controls to provide *ex post* governance to non-equity alliances. Given that the threat of knowledge misappropriation is larger the greater the partners' overlapping domains of technological expertise (Li *et al.*, 2008), we expect that partners having similar technologies will rely to a greater extent on hierarchical administrative mechanisms in non-equity alliances:

Hypothesis 1: The usage of hierarchical administrative mechanisms within a non-equity alliance is positively related to the technology overlap between partners.

Size of the Collaboration

Corporate governance research suggests that another important determinant of monitoring needs is the operational scale of a business, and we use similar logic to identify the size of an alliance as a key antecedent of administrative structures and hierarchy in non-equity alliances.

For our particular purposes, the size of a deal corresponds to the economic value of the transaction between partners. This value includes non-refundable payments made upfront and payments contingent on achievement of milestones and payments reimbursing for the full time equivalent (FTE) value of scientists (Edwards, 2007). Just as large and complex firms require mechanisms for decision ratification and monitoring (Fama and Jensen, 1983; Lehn *et al*., 2009). The greater number of researchers deployed on various projects, or the need to track the progression of the projects to determine contingent payments, the greater the informational requirements of the alliance and need for monitoring. This logic closely parallels corporate governance research on boards, which has suggested that the potential for moral hazard increases with the scale of operations such that there are net benefits from monitoring by the board (Bushman *et al.*, 2004; Boone *et al.*, 2007; Linck *et al.*, 2008). Likewise, a specialized administrative interface in an alliance can monitor actions and the use of inputs to achieve collaborative outcomes, and the net benefits of such monitoring are likely to be higher as the deal size increases.

The specialized administrative interface between the partner firms is analogous to boards in unitary corporations in several respects. The board is the preeminent administrative structure of a corporation and is staffed with representatives of the shareholders entrusted with the fiduciary duty of protecting the shareholders' interests (Johnson *et al*., 1996). The monitoring capacity of the board mainly stems from its seat at the apex of the administrative structure of the firm, which enables it to exercise its legally sanctioned authority to perform decision ratification and monitoring (Fama and Jensen, 1983). Similarly, an administrative interface staffed by members from partners is vested with requisite oversight authority over the alliance and can exert such authority to review the actions and performance of the alliance. In this way, partners

can use the information obtained through these interactions for mutual monitoring. Furthermore, although it is likely that monitoring is imperfect at the initial stages of the alliance, partners can use the administrative interface to learn about productive actions and hence improve monitoring over time and be in a position to sanction actions that lead to unproductive outcomes (Chassang, 2010).

A steering committee is the administrative interface with oversight responsibility of the alliance, so it can perform monitoring functions analogous to those of a board. First, just as the board in an organization exercises decision control, a steering committee with joint representation can be positioned at the apex of the decision hierarchy of the alliance and exercise control over the alliance. Like the size of the board, the size of the steering committee may be determined by the need for specialized knowledge or decision experts to conduct monitoring. Fama and Jensen (1983) also argue that the separation of decision management and decision control improves efficiency in complex organizations by better utilizing specific information that is costly to transfer. By extension of this logic to alliances, the steering committee can delegate responsibility about specific functions to subcommittees while retaining control to monitor these sub-committees. The arguments above thus suggest that larger alliances are more likely to utilize larger steering committees or a hierarchy of committees to govern the collaborative agreement.

Hypothesis 2: The usage of hierarchical administrative mechanisms within a non-equity alliance is positively related to the size of the collaboration.1

Interdependence

The foregoing discussion has focused on the monitoring function of administrative structures to address behavioral uncertainty partners face, but collaborators also encounter coordination challenges due to task-related uncertainty associated with the assignment of tasks and the alignment of actions (Gulati and Singh, 1998). The division of labor and specialization

among individuals or organizational units increases coordination costs (Heath and Staudenmayer, 2000) because of concurrent rise in communication and information processing costs (Tushman and Nadler, 1978). Such costs are accentuated in an alliance because organizational boundaries divide contingent activities, increasing the complexity and heterogeneity of the task environment. Partners may have to coordinate a wide range of functions such as design, manufacturing, and integration of complex subsystems (for example, jet engine development (Mayer and Teece, 2008)), or a wide range of specialist expertise (for example, drug discovery and development (Cockburn and Henderson, 2001)). Following a rich stream of research in organizational design, Gulati and Singh (1998) therefore associate coordination costs with the interdependence between partners.

Thompson (1967) originally conceived of three types of interdependence between different units of an organization that represent increasing difficulty in coordination based on the units' input-output relationships. These three types of interdependence in order of increasing interdependence are pooled, sequential, and reciprocal interdependence. Pooled interdependence between organizational units means that the activities of each unit are discrete with no direct input-output relationship. Sequential interdependence between organizational units means that a serial relationship exists between the activities' inputs and outputs. Reciprocal interdependence means that the inputs and outputs for the activities of any two units are reciprocally related. The three types of interdependence can be ordered along a scale of decreasing degree of predictability of interaction. This classification has implications for the structuring of alliances because the choice of interorganizational arrangement should fit the type of interdependence and the anticipated coordination costs (Aggarwal *et al.*, 2011; Grandori, 1997; Gulati and Singh, 1998).

The choice of coordination mechanisms must also take into account the burden of communication and decision making as interdependence increases. Partners have to rely on more interactive means of coordination and mutual adjustment to facilitate intensive communication and joint decision making cutting across hierarchy lines of partner organizations (Adler, 1995; Thompson, 1967). Coordination by managerial hierarchy is better suited to manage recursive information flows and operate under conditions of incomplete or evolving information structures (Sanchez and Mahoney, 1996). Partners can improve the efficiency of mutual adjustment by formalizing joint decision-making and by delineating decision-making authority (Gulati and Singh, 1998). Doing so, partners can simplify the decision-making process, make interactions more predictable, and implement planning and communication routines, thereby enhancing the efficiency of information transmission and processing.

A steering committee that oversees the alliance activities can address coordination concerns in several ways. First, it can serve as a single entity that bridges the administrative systems of the partners to centralize decision making. It enables partners to jointly set goals and allows them to account for interdependencies in decomposing tasks and assigning roles and responsibilities. Second, it provides a forum for key decision makers from both the partners to interact directly and regularly to exchange information. Such interaction not only keeps partners abreast of the progress of various alliance activities, but it also enables them to handle exceptions and adapt to contingencies through joint reviews and updating plans.

Partners can also introduce elements of hierarchical control through functional subcommittees to manage interdependencies for several reasons. First, these committees can reduce the information processing load on the steering committee (e.g., Galbraith, 1974). Second, these structures enable partners to better manage the rich information flow that

accompanies significant interaction among decisions. Partners can reduce the information transmission load on the communication channels by grouping functionally similar activities under the authority of specific functional committees. Third, differentiation at the subordinate committee level will increase the responsiveness, and hence the adaptability, of the alliance to task uncertainties (Gulati *et al.*, 2005). As noted above, the steering committee is able to make adjustment over time, such as when resolution is needed to decision conflicts that emerge across the subordinate committees. By creating requisite functional differentiation and integration in the committee structure, partners can therefore alleviate coordination concerns that arise because of interdependencies. We therefore hypothesize:

Hypothesis 3: The usage of hierarchical administrative mechanisms within a non-equity alliance is greater for alliances involving sequential interdependence than pooled interdependence.

Hypothesis 4: The usage of hierarchical administrative mechanisms within a non-equity alliance is greater for alliances involving reciprocal interdependence than sequential interdependence.

METHODS

Sample

We test our hypotheses using a hand-collected dataset of alliance contracts from the biotechnology industry. The biotech industry provides an interesting and appropriate context for our investigation of alliance governance for several reasons. First, alliance activity in the biotechnology industry has been very extensive and has attracted considerable research (e.g., Hagedoorn 1993, 2002). Second, while firms in this industry collaborate to access complementary resources possessed by other firms (Arora and Gambardella, 1990; Rothaermel, 2001), these alliances are fraught with appropriation problems, task uncertainties, and coordination challenges (Baker *et al.*, 2008; Hagedoorn and Hesen, 2007; Katila and Mang,

2003; Santoro and McGill, 2005). Finally, this industry is extensively tracked, thus enabling access to very detailed information about the governance of alliances. We were therefore able to obtain rich information on the design of alliances between pharmaceutical firms and biotechnology firms as well as between biotechnology firms.

Our main source of information is alliance contracts compiled by Deloitte Recap (Recap). Recap specializes in consulting services to the biopharmaceutical industry, particularly with respect to alliance formation. Recap compiles alliance information primarily from the filings of biopharmaceutical companies with the Securities and Exchange Commission (SEC). A recent analysis found the Recap database to be robust and representative in its coverage of alliances in the biopharmaceutical industry (Schilling, 2009). In addition, several recent studies in management, finance, and economics have used alliance data from the databases of Recap to conduct a variety of fine-grained analyses of alliance contracts (Adegbesan and Higgins, 2011; Lerner *et al.*, 2003).

We also merged data from Recap with information from two other sources to construct the final dataset. First we complemented data from the Recap database with data from the alliances module of Thomson Financial's Securities Data Corporation (SDC) database. We use these merged data in order to track their prior alliances. We also obtained patent data from the US Patent and Trademarks Office (USPTO) and National Bureau of Economic Research (NBER) and matched it with the Recap dataset after tracking corporate histories and name changes.

We focus on non-equity alliances formed during the 1980-2010 timeframe. This time period covers almost the entire span of the biotechnology industry. We include contracts that are classified as research, development, co-development, co-promotion, collaboration, licensing, marketing, distribution, manufacturing or supply agreements. In order to be able to construct

measures on firms' technological knowledge stocks and their similarity, we also consider those alliances where both the partners have patented at least once with the USPTO during the time period and where contract analysis by Recap is available, leading to a final sample of 492 non-equity alliances.

Measures and Analysis

Dependent variables. As noted above, we followed Radner (1992) in viewing hierarchy as a ranked tree with a root of formal authority. Consistent with this definition, we characterize the hierarchy of the administrative interface in two different ways. First, we focus only on the steering committee and its size. Second, we construct a variable that orders different committee structures on the basis of the extent to which they exhibit hierarchy.

We use a dichotomous variable to identify whether partners have set up a joint steering committee. Thus, *Steering committee* equals one when the contract describes the makeup, role and responsibilities of a steering committee, and zero otherwise. Because this dependent variable is binary, we specify a probit model to test our hypotheses. We were also able to gather information from alliance contracts on the size of the steering committee, which is another indicator whether this administrative mechanism is an important facet of the non-equity alliance's governance. Specifically, we count the number of members on the steering committee specified in the contract. Since the steering committee has at least one member from each of the collaborators, *Steering committee size* takes values from two onwards. Given the count nature of this dependent variable, we specify negative binomial models that account for potential over-dispersion to test our hypotheses.

Given that partners may choose to set up multiple layers of joint committee structures (Deck and Strom, 2002), we measure the hierarchical nature of the alliance's committees in two

alternative ways to capture the ways in which partners might vertically elaborate these administrative mechanisms to govern their collaborative agreement. First, we classify the committee structure of an alliance into three increasingly-hierarchical levels. The base level is no committee structures contracted for at the time of alliance formation. Next, partners might have a committee structure that includes either a steering committee or one or more functional committees. Finally, the parties might use both a steering committee and one or more functional committees. Accordingly, the variable *Hierarchy (2 levels)* may take integer values in the range of zero to two. Second, as an alternative way to measure hierarchy, we classified committee structures into four increasingly-hierarchical levels: (0) no committees, (1) a committee structure that includes just a project team, (2) one or more functional committees are present, (3) a steering committee only is present, and (4) a steering committee and one or more functional committees exist. Accordingly, the variable *Hierarchy (4 levels)* may take integer values in the range of zero to four representing each of the levels. In supplemental analyses we combined categories 2 and 3 and obtained the same interpretations (results available upon request). Because of the ordinal nature of the two committee hierarchy variables we specify ordered probit models to test our hypotheses using these dependent variables.

Independent variables. Our first theoretical variable is the overlap of partner's technological resources. For measuring the partner's *Technology overlap*, we employ the angular measure first used by Jaffe (1986). This measure has been extensively used in recent research on alliances to characterize the technological resources of partners (Gomes-Casseres *et al.*, 2006; Li *et al.*, 2008; Sampson, 2004). For this measure, the technological position of a firm is first determined by the firm's distribution of patents across various patent classes. We assign a technology class as the original three-digit technology class under which the USPTO classifies

an invention. Each patent assigned to a firm is represented as vector with one on the dimension of the original patent class and zero on the other patent classes, and we then aggregate these patent vectors at the firm level for each of the partners. Following the suggestion of Benner and Waldfogel (2008), we account for all patents applied for by a partner before signing the alliance. *Technology overlap* is bound between zero and one with values closer to one indicating greater overlap in partners' technological resources.

Our second theoretical variable is the size of the deal (Higgins, 2007). We measure *Deal size* as the maximum possible payments made through the life of the alliance agreement (Robinson and Stuart, 2007). This variable corresponds to the total budget of the partnership and therefore includes milestone payments for possible products and R&D payments that represent costs of research and development, as well as the cost of employing researchers to meet the full-time equivalent employee requirements (Edwards, 2007). Because *Deal size* represents the number of employees in monetary terms it is also consistent with the use of revenues or number of employees for measuring the complexity of a firm as a determinant of governance by boards of directors (Linck *et al.*, 2008). Given skewness that was evident in the size of deals, we employed a logarithmic transformation for this variable.

Our final theoretical variables are the levels of interdependence between the partners. Prior research has operationalized the interdependence typology in an interorganizational context based on the strategic rationale of partners for entering into the alliance (Gulati and Singh, 1998). We use Recap's description of alliance agreements and their use of 25 different categories of collaborations based on an analysis of the contracts. This classification is in part based on the division of activities between the partners. For example, agreements are classified within the "Collaboration" category if both the partners participate in research, development and

commercialization activities, whereas agreements are classified under "Research" or "Development" when one of the partners is performing those activities while commercialization is left to the other partner. We use two dummy variables to represent *Reciprocal interdependence* and *Sequential interdependence*, with pooled interdependence being the omitted category. Specifically, we coded *Reciprocal interdependence* equal to one for agreements classified under "Collaboration" and "Co-development" types, and zero otherwise; *Sequential interdependence* equals one for agreements classified under "Research", "Development" and "Manufacturing" types, and zero otherwise. Agreements that are classified as licensing, marketing, promotion and distribution agreements comprise the pooled interdependence category.

Control variables. We include a series of controls for attributes of the firms entering into the alliance as well as the attributes of the alliance that might be related to the sources of partners' monitoring and coordination needs as well as the alliance's administrative mechanisms. At the firm level, we control for alliance experience of both partners since companies might learn to manage alliances better with experience and hence may require less hierarchical mechanisms to coordinate and monitor the alliance activities (e.g., Anand and Khanna, 2000; Colombo, 2003; Hagedoorn et al., 2009). Specifically, we measure *Alliance experience of R&D firm* and *Alliance experience of client firm* as the number of previous alliances in which the partner participated before signing the focal alliance (Hoang and Rothaermel, 2005). The partner that offers the R&D services or the technology is denoted as the R&D firm and the partner is denoted as the client firm. To construct these measures, we relied on a merged dataset of alliance deals that is the union of the Recap and SDC databases. We next control for the knowledge stocks of both of the partners, in part because firms with significant knowledge stocks in R&D possess the absorptive capacity to overcome challenges in coordinating knowledge transfer through alliances

(Dushnitsky and Lenox, 2005; Veugelers, 1997). We measure *Knowledge stock of R&D firm* and *Knowledge stock of client firm* as forward citation weighted patent counts of patents owned by the partners prior to the formation of the focal alliance (Argyres and Silverman, 2004; Hall *et al.*, 2005). Given the skewness we observed for the knowledge stock as well as experience measures, we used logarithmic transformations for these variables.

At the alliance level, we also controlled for several variables that might be related to the theoretical variables as well as the administrative mechanisms firms employ in their collaborative agreements. First, we account for the complexity of the contract that governs the alliance. An elaborate contract between the partners that incorporates adequate safeguards and contingency planning can mitigate the *ex post* concerns (Argyres et al., 2007). To control for these effects we include *Contract length* measured by the byte size of the contract analysis by Recap (Robinson and Stuart, 2007). In supplemental analysis, we also used a count of the number of provisions that are specified in the contract. We found that both measures yielded similar results and are highly correlated ($r=0.55$, $p<0.001$). Second, partners can also mitigate moral hazard concerns by suitable incentive structures. To control for these effects, we include *Milestone payments*, measured by milestone payments as a percent of total deal value. Third, we incorporated a control for the number of prior relationships between the partners. Previous research suggests that prior partnerships can facilitate the development of trust between partners, which in turn can mitigate the threat of opportunism and the need for formal governance mechanisms (Gulati, 1995; Gulati and Sytch, 2008; McEvily *et al.*, 2003). Furthermore, repeated ties with a partners also helps in the development of stable routines that can address coordination and communication problems in alliances. We measure *Prior ties* by counting the number of prior partnerships between the alliance partners (Gulati et al., 2009) and use a logarithmic

transformation. Fourth, we account for the stage of the technology's development when partners enter into the collaborative agreement. Recent research suggests that contracting problems are more severe in the early part of the drug development cycle than in the later stages (Lerner and Malmendier, 2010). Contractual incompleteness can increase the importance of administrative structures as *ex post* governance mechanisms in high-tech collaborations, and task uncertainty in early stage research can also increase coordination needs (Rothaermel and Boeker, 2008). To control for these effects we include *Early stage deal* as a dummy, which takes on a value of one when the lead molecule has not yet been identified, and zero otherwise.

Finally, we controlled for several other sources of unobserved effects. We distinguished deals between two biotechnology firms versus a biotechnology firm and pharmaceutical company by including an indicator variable *Biotech-biotech deal* (Lerner *et al.*, 2003). We also incorporated a series of fixed effects for the focal therapeutic area of research (*Therapeutic area effects*) (Macher and Boerner, 2006), the technological domain of the alliance (*Technology area effects*) (Adegbesan and Higgins, 2011) to account for differences in contracting concerns, and the year in which the collaborative agreement was signed to capture unobserved differences in alliance governance over time (*Time fixed effects*).

RESULTS

Table 1 presents descriptive statistics and a correlation matrix. We note that a steering committee is present in 34% of the agreements and the mean number of committees is one. The mean size of the steering committee when a steering committee is present is 5.5 members. 37 percent of collaborations involved neither functional nor steering committees at the inception of the alliance, 1.6 percent involved only a project team, 27 percent had one or more functional committees present, 17.3 percent used a steering committee only, and 17.5 percent had a steering

committee as well as one or more functional committees. The average size of the sampled deals was $106 million, and was $199 million for deals with steering committees and $60 million for collaborative agreements without steering committees (i.e., $t=7.21$, $p<0.001$). Coordination requirements of the sampled alliances were generally significant, with 49 percent having reciprocal interdependence and 30 percent sequential interdependence. Steering committees were present in 51 percent of the alliances with reciprocal interdependence and 23 percent of the alliances with sequential interdependence (both $p<0.001$), whereas 11 percent of alliances with pooled interdependence had steering committee. Client firms with more alliance experience and greater technological knowledge stocks were more likely to enter into larger deals, collaborations having reciprocal interdependence, and early stage deals (all $p<0.001$). Given the correlations among some of the independent variables, we examined variance inflation factors but observed that the maximum variance inflation factor (VIF) is 3.3, well below the critical value of ten, providing no indication of multicollinearity problems.

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Inset Table 1 about here
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To provide additional descriptive statistics on the various committees that firms employ in non-equity alliances, Table 2 presents the conditional relative frequencies of various committees observed in the contracts. The table suggests that partners often set up specialized functional committees to manage alliance activities, though the frequency of these individual committees is less than the incidence of steering committees (ranging from 1.5 to 20 percent). However, at least a steering or functional committee is chosen in 61 percent of the alliances, at least one functional committee appears in 27 percent of the alliances, and 17.5 percent of the alliances have a hierarchical committee structure with a steering committee overseeing one or

more functional subcommittees. Specialized committees that manage research, development and commercialization functions are the most frequently observed committees. In addition, steering committees are most likely to be employed jointly with development committee and commercialization than other committees. This overall pattern is also consistent with the observation that non-equity alliances are more likely in later stage deals than early stage deals where equity alliances are more prevalent (Robinson and Stuart, 2007). Among the functional committees, development and commercialization committees coexist frequently. Finally, the higher incidence of patent committees with research committees suggests that partners pay attention to the management of intellectual property at early stages through these committee structures. In summary, the descriptive statistics appearing in Tables 1 and 2 reveal that administrative structures often exist in non-equity alliances, and there is also heterogeneity in the presence and number of these committees as well as the level of hierarchy that is manifest in these collaborative agreements.

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The remaining tables present results from multivariate analyses for hypothesis testing purposes. Table 3 presents estimation results for the determinants of the presence or absence of steering committees and for the determinants of steering committee size. Specifically, Models 1 and 2 present probit specifications of the choice of a steering committee, and Models 3 and 4 present negative binomial specifications of the size of the steering committee. Models 1 and 3 represent baseline specifications consisting of the control variables, and Models 2 and 4 augment these models with the theoretical variables. The substantial improvement in model fit demonstrates the joint significance of the theoretical variables (both $p<0.001$).

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Our first hypothesis suggested that overlap in partners' technologies will have a positive effect on their usage of a steering committee, and the size of this committee, in governing the alliance due to the appropriability hazards that accompany greater technological overlap. Models 2 and 4 show that technology overlap positively and significantly affects the choice of steering committee ($p<0.05$) and its size ($p<0.01$), providing support for Hypothesis 1. The mean effect of one standard deviation increase in technological overlap is an increase in the probability of firms employing a steering committee by 22.3 percent ($p<0.05$).

Our second hypothesis borrowed from prior corporate governance research on the scale of operations as a determinant of firms' monitoring needs (Boone et al., 2007), positing that partners are more likely to employ a hierarchical administrative interface in the form of a steering committee, and use a steering committee with more members, in order to govern larger deals owing to their greater complexity. In Models 2 and 4, deal size has a positive and significant effect on the choice of steering committee ($p<0.05$) and its size ($p<0.001$). Thus, strong support exists for Hypothesis 2. The mean effect of a one standard deviation increase in the size of the deal on a logarithmic scale is an increase in the probability of firms employing a steering committee by 30.6 percent ($p<0.05$).

Our final hypotheses suggested that collaborations involving higher levels of interdependence are more likely to use steering committees, and larger steering committees, given their coordination needs. In Models 2 and 4, reciprocal interdependence between partners has a strong and highly significant effect on the choice of steering committee ($p<0.001$) and its size ($p<0.001$). The effect of sequential interdependence is also significant in both equations

($p<0.05$). A comparison of the parameter estimates for reciprocal and sequential interdependence suggests that the effect of reciprocal interdependence is more than the effect of sequential interdependence (both $p<0.01$). The results therefore support Hypotheses 3 and 4 that partners tend to employ a steering committee, and a larger committee, the higher is the level of interdependence for the collaborative agreement.

Table 4 offers ordered probit specifications that model the choice of hierarchy in committee structures, using two alternative measures of hierarchy. Models 1 and 2 use the more aggregate measure of hierarchy (2 levels), and Models 3 and 4 use the more disaggregated measure of hierarchy (4 levels). As before, Models 1 and 3 incorporate the control variables only, and Models 2 and 4 add the theoretical variables for hypothesis testing (both $p<0.001$). Estimation results for both measures of hierarchy indicate partners choose more elaborate hierarchical structures to govern their collaborative agreements when there is greater overlap in their technologies (both $p<0.05$), providing support for H1. Models 2 and 4 also demonstrate that more hierarchical committee structures are used for deals of larger size ($p<0.05$ in Models 2 and 4), consistent with H2. Consistent with Hypotheses 3 and 4, these models also suggest that reciprocal and sequential interdependence are strongly associated with the choice of hierarchical committee structures (both $p<0.001$). Once again, reciprocal interdependence contributes to greater hierarchy than does sequential interdependence (both $p<0.001$).

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DISCUSSION

Contributions and Implications

Although alliance governance research recognizes that incompleteness of contracts limits their ability to address *ex post* concerns that arise during alliance implementation, the literature has paid scant attention to the administrative mechanisms that can offer *ex post* supports to collaboration in non-equity alliances. We sought to advance research on the design of governance mechanisms in alliances by studying various committee structures that partners employ in high tech collaborations. We suggest that many non-equity alliances involve elements of hierarchy, and argued and shown that the elaboration of committee structures is determined by the monitoring and coordination needs presented by an alliance (Gulati and Singh, 1998). Our theoretical arguments and findings suggest that non-equity alliances are governed by a rich set of administrative mechanisms beyond contractual safeguards. Our findings suggest that governance complexity not only entails the complexity of contractual provisions (Parkhe, 1993; Puranam and Vanneste, 2009; Reuer and Arino, 2007) but also the complexity of the administrative interface between partners.

By sharply focusing on committee structures in non-equity alliances, our paper sheds light on the variety and complexity of the structures designed to govern and manage high tech collaborations. The structure of these committees may vary from a single functional committee to an elaborate hierarchy of committees with well-defined authority relationships and oversight functions. The organization of these committees with explicitly specified authority and oversight over collaborative activities seem analogous to the decision hierarchy in a unitary organization with the board at its apex (Fama and Jensen, 1983). Beyond identifying heterogeneity in this dimension of formal governance, we have identified monitoring and coordination needs as key

antecedent conditions prompting collaborators to use more elaborate hierarchies in their nonequity alliances. In contrast to unitary organizations, we have suggested knowledge misappropriation as a unique determinant of monitoring needs in collaborative agreements, and coordination needs are also a unique determinant of governance in the setting of strategic alliances.

By investigating administrative mechanisms within non-equity alliances, our study also contributes by addressing the conflation of incentive alignment and administrative control along the market-hierarchy continuum. More specifically, the canonical taxonomy of hybrid organizations consists of the discrete structural forms of equity and non-equity alliances, where equity alliances are distinguished by greater incentive alignment through shared ownership and administrative control through a joint board (Pisano, 1989). Given that equity alliances combine these features, prior studies examining when firms use equity versus non-equity alliances are not able to isolate monitoring effects. By focusing on the administrative mechanisms present within non-equity alliances, we are able to do so, and we also conclude that rich administrative controls are not limited to equity alliances. For executives, our arguments and findings therefore suggest they might (a) consider administrative mechanisms in addition to other governance mechanisms in alliances (e.g., contractual safeguards, relational governance, etc.), (b) evaluate the need to build in administrative controls in addition to mutual hostages in non-equity alliances (Oxley, 1997), and (c) assess whether the *ex post* governance mechanisms available through non-equity alliances might be adequate or more efficient compared to those provided by equity arrangements.

Finally, our findings also complement recent research on alliance design from a control rights perspective. Employing a property rights approach to the incompleteness of contracts

(Grossman and Hart, 1986), recent research on the design of interfirm agreements suggests the allocation of control rights over various decisions as an efficient means to overcome contractibility problems (e.g., Elfenbein and Lerner, 2003; Lerner and Merges, 1998). However, this line of research does not indicate the mechanisms through which these specific decision rights are exercised. The hierarchical structure of committees we study provides a primary platform where these control rights are actuated. Our findings may open some interesting questions in this line of research. As a specific example, recent research in this research stream suggests that the allocation of termination rights with reversion of property rights as a means to overcome contractibility problems (Lerner & Malmendier, 2010). It would be interesting to examine how committees geared to handling conflicts interact with such rights to shape collaboration and termination events.

Limitations and Future Directions

Apart from the future avenues for research we have already mentioned, our study also has several limitations that future research can address. First, our study is based on alliances in the biotechnology industry, in which firms are involved in complex forms of collaborative activity that may have unique contracting conditions. It would be useful to examine the administrative mechanisms we study in other industries in order to probe the generalizability of our findings. In addition, our study is limited to dyadic alliances, so extensions could examine how the structures are designed in multi-partner alliances (e.g., Gong *et al.*, 2007; Li *et al.*, 2011).

Second, our study considers structuring decisions only at the inception of the alliance. Although this enables us to capture partners' design of collaborative agreement and enhance comparability, partners may also adapt these structures as an alliance evolves to improve alliance management. Future research can analyze the dynamics of administrative mechanisms in order to

understand how firms alter these control mechanisms to account for transaction conditions (e.g., Reuer *et al.,* 2002). For instance, it would be interesting to investigate the extent to which steering committees add or alter functional subcommittees and investigate the degree to which the administrative mechanisms within the alliance coevolve with the parent firms' strategies (Koza and Lewin, 1998).

Finally, our study explicitly focuses on revealing the administrative mechanisms supporting non-equity alliances and their antecedents. Given that these control mechanisms are chosen with specific monitoring or coordination concerns in mind, it would be useful to examine how they affect specific outcomes such as knowledge transfer or new products launched (e.g., Nerkar and Roberts, 2004). Moreover, our study is ultimately silent on their efficiency implications or broader performance outcomes, so it would be valuable to investigate how these and other formal governance mechanisms contribute to alliance performance (Mjoen and Tallman, 1997). In investigating the immediate consequences of various committee structures in non-equity alliances, it would be interesting to consider the specific ways in which the administrative mechanisms we study fill in gaps in contracts that are evident *ex post*. As one example, it would be worthwhile to study how the administrative mechanisms potentially shape the incidence and resolution of conflicts between partners concerning their rights and obligations in collaborative agreements. In addition to considering these interactions across types of formal governance mechanisms, such investigations might also join recent research on the ways that formal and relational governance potentially complement each other. For instance, it would be valuable to determine whether the administrative mechanisms we study potentially drive out the development of relational norms or can facilitate informal governance mechanisms such as trust.

CONCLUSION

Existing research on alliance governance has considered non-equity alliances as pure contractual forms and has recently devoted considerable attention to partners' design of specific contractual provisions. Our study investigates administrative mechanisms in non-equity alliances and reveals an array of committee structures that build in hierarchy into non-equity alliances in response to partners' monitoring and coordination needs. In particular, we argue and find that partners put in place more elaborate hierarchical controls due to the benefits of monitoring in large alliances and those subject to knowledge misappropriation concerns and when interdependent activities present substantial coordination needs. We hope that this study encourages additional research on administrative mechanisms in interfirm collaboration as an important yet neglected aspect of alliance governance and management.

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Table 1
Descriptive Statistics and Correlation Matrix[a]

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.Steering committee	1.00																
2.Size of steering committee	**0.76**	1.00															
3.Hierarchy (2 Levels)	**0.72**	**0.52**	1.00														
4.Hierarchy (4 Levels)	**0.83**	**0.62**	**0.97**	1.00													
5.Alliance experience of R&D firm	0.07	0.02	**0.11**	**0.09**	1.00												
6.Alliance experience of client firm	**0.22**	**0.18**	**0.34**	**0.34**	-0.01	1.00											
7.Knowledge stock of R&D firm	**-0.08**	**-0.10**	-0.04	**-0.08**	**0.50**	**-0.21**	1.00										
8.Knowledge stock of client firm	**0.08**	**0.14**	**0.15**	**0.15**	**-0.11**	**0.57**	**-0.11**	1.00									
9.Contract length	**0.37**	**0.30**	**0.50**	**0.50**	**0.11**	**0.36**	-0.07	0.08	1.00								
10.Milestone payments	0.02	0.00	0.06	0.05	0.08	**0.10**	0.05	-0.01	**0.11**	1.00							
11.Prior ties	0.01	-0.02	0.01	0.01	0.08	**0.16**	0.02	0.06	**0.08**	-0.05	1.00						
12.Early stage deal	0.04	0.04	0.08	0.08	-0.09	**0.17**	**-0.19**	**0.16**	-0.03	-0.09	0.07	1.00					
13.Biotech-biotech deal	-0.00	-0.00	**-0.09**	-0.07	-0.06	**-0.22**	-0.03	**-0.34**	0.01	-0.00	-0.01	0.01	1.00				
14.Technology overlap	**0.14**	**0.12**	**0.16**	**0.16**	0.03	**0.11**	0.07	0.09	0.08	0.02	-0.04	-0.08	**0.14**	1.00			
15.Deal Size	**0.37**	**0.29**	**0.52**	**0.51**	**0.13**	**0.49**	**-0.11**	**0.21**	**0.55**	**0.23**	-0.04	-0.08	-0.05	**0.19**	1.00		
16.Reciprocal interdependence	**0.34**	**0.24**	**0.45**	**0.46**	0.00	**0.37**	**-0.15**	**0.18**	**0.36**	0.04	**0.12**	**0.24**	0.04	**0.38**	**0.10**	1.00	
17.Sequential interdependence	**-0.14**	**-0.11**	**-0.18**	**-0.17**	-0.08	**-0.13**	-0.02	-0.05	**-0.17**	-0.00	**-0.13**	-0.08	**-0.16**	**-0.14**	**-0.64**	**-0.15**	1.00
Mean	0.35	1.42	0.79	1.77	2.59	3.62	1.58	3.70	22.89	0.48	0.07	0.25	0.19	0.41	3.05	0.49	0.30
S.D.	0.47	2.52	0.72	1.52	1.15	1.54	2.03	2.70	11.84	0.60	0.23	0.43	0.39	0.32	2.00	0.50	0.46

[a] N=492. Values in bold are significant at $p<0.05$.

Table 2

Conditional Relative Frequencies of Committees

Committee	#	%	1	2	3	4	5	6	7
1. Steering committee	171	34.8		0.13	0.24	0.20	0.07	0.02	0.02
2. Research committee	93	18.9	0.24		0.22	0.10	0.02	0.05	0.02
3. Development committee	100	20.3	0.41	0.20		0.46	0.12	0.04	0.04
4. Commercialization committee	64	13.0	0.52	0.13	0.69		0.18	0.08	0.09
5. Manufacturing committee	19	3.9	0.63	0.11	0.63	0.63		0.05	0.05
6. Patent committee	11	2.2	0.36	0.45	0.36	0.36	0.09		0.00
7. Finance committee	7	1.4	1.00	0.28	0.57	0.85	0.14	0.13	

a N=492. Column values indicate the rate of occurrence of a committee given the presence of the committee indexed by the row.

Table 3

Determinants of Steering Committee and Steering Committee Size[a]

Variables	Steering Committee (1)	Steering Committee (2)	Steering Committee Size (3)	Steering Committee Size (4)
Constant	-2.398***	-3.086***	-1.362*	-2.335***
	(0.408)	(0.457)	(0.617)	(0.605)
Year fixed effects	76.18***	59.35***	6880.29***	3527.20***
Therapeutic area fixed effects	13.17*	13.36*	6.95	5.17
Technology fixed effects	2.38	3.67	4.70	3.73
Alliance experience of R&D firm	0.060	0.108	0.033	0.115
	(0.072)	(0.072)	(0.118)	(0.110)
Alliance experience of client firm	-0.026	-0.077	-0.006	-0.124
	(0.068)	(0.072)	(0.099)	(0.101)
Knowledge stock of R&D firm	-0.062	-0.057	-0.206**	-0.217**
	(0.042)	(0.043)	(0.069)	(0.077)
Knowledge stock of client firm	0.024	0.004	0.092	0.059
	(0.035)	(0.037)	(0.061)	(0.058)
Contract length	0.041***	0.028***	0.051***	0.024*
	(0.008)	(0.009)	(0.011)	(0.009)
Milestone payments	-0.186	-0.300	-0.473	-0.873*
	(0.182)	(0.226)	(0.309)	(0.352)
Prior ties	-0.110	-0.090	-0.993*	-0.720
	(0.268)	(0.272)	(0.440)	(0.448)
Early stage deal	0.128	0.066	0.157	0.057
	(0.197)	(0.204)	(0.284)	(0.256)
Biotech-biotech deal	-0.157	-0.192	-0.106	-0.051
	(0.187)	(0.205)	(0.273)	(0.326)
Technology overlap		0.538*		0.741**
		(0.225)		(0.284)
Deal size		0.121*		0.348***
		(0.057)		(0.071)
Reciprocal interdependence		0.999***		1.471***
		(0.251)		(0.355)
Sequential interdependence		0.509*		0.681*
		(0.244)		(0.346)
Dispersion parameter			4.375***	3.698***
			(0.578)	(0.503)
Log likelihood	-250.30	-233.87	-598.10	-582.38
Model χ^2	134.99***	167.85***	71.50**	102.94***

[a] N = 492. ***p<0.001, **p<0.01, *p<0.05,†p<0.1. 2D Clustered robust standard errors are in parentheses. For year, therapeutic area and technology area fixed effects we report χ^2values of joint significance.

Table 4

Determinants of Hierarchical Committee Structure [a]

	Hierarchy (2 Levels)		Hierarchy (4 Levels)	
	(1)	(2)	(3)	(4)
Cut Point 1	1.009*	1.471***	0.760*	1.232***
	(0.405)	(0.415)	(0.372)	(0.384)
Cut Point 2	2.817***	3.419***	0.824*	1.302***
	(0.404)	(0.422)	(0.371)	(0.384)
Cut Point 3			1.758***	2.320**
			(0.730)	(0.389)
Cut Point 4			2.489***	3.091***
			(0.747)	(0.388)
Year fixed effects	605.34***	634.24***	642.52***	678.65***
Therapeutic area fixed effects	12.19*	10.18†	14.19*	11.56*
Technology fixed effects	7.77	6.86	5.86	5.74
Alliance experience of R&D firm	-0.006	0.032	0.005	0.045
	(0.060)	(0.058)	(0.056)	(0.055)
Alliance experience of client firm	-0.045	-0.112	-0.055	-0.118†
	(0.068)	(0.072)	(0.063)	(0.067)
Knowledge stock of R&D firm	-0.012	-0.000	-0.036	-0.028
	(0.035)	(0.038)	(0.034)	(0.036)
Knowledge stock of client firm	0.038	0.020	0.041	0.023
	(0.030)	(0.033)	(0.029)	(0.031)
Contract length	0.052***	0.039***	0.047***	0.035***
	(0.007)	(0.007)	(0.007)	(0.007)
Milestone payments	-0.123	-0.192	-0.153	-0.231
	(0.141)	(0.188)	(0.147)	(0.189)
Prior ties	-0.221	-0.222	-0.198	-0.172
	(0.271)	(0.280)	(0.246)	(0.248)
Early stage deal	0.346	0.277†	0.249	0.170
	(0.156)	(0.158)	(0.154)	(0.158)
Biotech-biotech deal	-0.645***	-0.718***	-0.529***	-0.582***
	(0.163)	(0.177)	(0.160)	(0.173)
Technology overlap		0.390*		0.435**
		(0.181)		(0.168)
Deal size		0.112*		0.103*
		(0.047)		(0.043)
Reciprocal interdependence		1.137***		1.134***
		(0.196)		(0.184)
Sequential interdependence		0.567***		0.616***
		(0.176)		(0.164)
Log likelihood	-370.29	-344.58	-554.99	-526.84
Model χ^2	276.31***	327.72***	263.72***	320.03***

[a] N = 492. ***p<0.001, **p<0.01, *p<0.05,†p<0.1. 2D Clustered robust standard errors are in parentheses. For year, therapeutic area and technology area fixed effects we report χ^2 values of joint significance.