Disrupting Relational Contracts

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Abstract. This article applies under-utilized research in economic sociology to illuminate an important yet overlooked aspect of relational contracts. A puzzle motivates the study: Why are biopharmaceutical companies with greater social capital more likely to use certain costly formal contract terms, typically associated with low social capital, in their alliance agreements? Doing so inverts the relationship between formal and informal governance as it is conventionally understood. The article introduces a theory of relational contracting built on the intuition that collaborators must balance the benefits social networks provide regarding the transfer of reputational information with the costs, such as protecting proprietary technology and maintaining effective collaborative routines, that increase as parties become more embedded within a network. As those

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latter costs rise, formal contracts are used more frequently to control certain information flows, which can disrupt the operation of reputational constraints, a possibility overlooked by prior research focused upon opportunism problems. The article then presents the results of qualitative and quantitative analyses of contracting practices in the biopharmaceutical industry, and those results provide evidence supporting that "disruptive" role for formal agreements. As such, the article re-frames the relationship between formal and informal contracts as contingent, rather than fixed, and invites us to broaden our focus on economizing transaction costs to include the question of how the "transformation costs" of recombining institutions from deal to deal can be optimally managed.

1 Introduction

One of the most important insights of contracts scholarship in the second half of the 20th century is the realization that many commercial agreements are governed not by one but two enforcement regimes. Against the classical view of contract institutions, which saw formal doctrine as the sole recourse for an aggrieved party, Macauley's and Macneil's pioneering work (Macaulay 1963; Macneil 1974–1975; Macneil 1977–1978) argued that informal enforcement mechanisms play a significant role in enforcing contractual obligations. Subsequent research has demonstrated that such "relational contracting" (Macneil 1977–1978) is a hallmark of many modern product and capital markets, from Jewish diamond merchants in New York City (Bernstein 1992; B. D. Richman 2006; B. Richman 2017) to Silicon Valley (Saxenian 1996; Saxenian 2007; Gilson 1999) to the ethnic Chinese merchants of Southeast Asia (Landa 2016). Contemporary capitalism is organized in networks, and its infrastructure is, to significant extent, social (W. Powell 1991).

Research has found that relational contracting is particularly important in the modern biopharmaceutical industry (R. Gulati 1995; W. W. Powell, Koput, and Smith-Doerr 1996).[1] Many research-focused biotechnology companies lack capital and certain types of expertise, such as navigating regulatory processes and product marketing (see, e.g., Rothaermel and Boeker 2008; Yang, Zheng, and Zhao 2014). Financing is often secured either through the venture capital market or through contractual alliances with larger industry players (Nicholson 2012). Those alliance relationships are often a source of not only capital but also expertise, in the sense that the more established partner—such as a long-standing pharmaceutical firm—cooperates in the development of the product, shepherds the drug through regulatory approval, and executes the marketing strategy. Such alliances are attractive for more established companies, which increasingly struggle to innovate drugs internally and which use alliances as pre-

[1] I use the term "biopharmaceutical" when referring to the broad market that includes both companies engaged in developing more traditional small-molecule drugs and companies developing large-molecule biological drugs.

ludes to a complete acquisition (see, e.g., Higgins and Rodriguez 2006; Shi and Prescott 2011). As biotech and pharmaceutical companies establish such alliance relationships with multiple partners, an industry network forms, creating the web of interactions characteristic of relational contracting.

Relational contracting is undeniably important, but that does not mean it always operates smoothly. Numerous studies have found that alliances in a variety of industries routinely fail (see Park and Ungson 2001), which has led researchers to call for a theory of network failure as much as a theory of network success (Schrank and Whitford 2011). In the biopharmaceutical industry, for instance, McKinsey has noted that, of the approximately $1 trillion in shareholder value generated in the 1990s, around $550 million was destroyed by biopharmaceutical companies' failed R&D investments from 2000 to 2010, a period during which biopharmaceutical companies not only increased their R&D budgets but also engaged in significantly more cross-company collaborations (Dhankar et al. 2012).

Scholarship suggests that part of the problem may be companies' failure to fully leverage informal governance mechanisms. One longstanding line of research argues that formal contracts interfere with social norms and therefore act as *substitutes* for informal governance, suggesting that relational contracting's limits may arise from a legal infrastructure that is not well calibrated to its needs (Goetz and R. E. Scott 1985; Bernstein 1996; R. E. Scott 2003; Schwartz and R. E. Scott 2003). More recent research argues that heterogeneous modern markets may not enjoy the consistent connections between market participants necessary for informal governance to operate efficiently, and therefore parties might use formal institutions as *complements* to foster the information exchanges necessary for relational contracting (M. C. Jennejohn 2008–2009; Gilson, C. F. Sabel, and R. E. Scott 2009; Gilson, C. F. Sabel, and R. E. Scott 2010; Hadfield and Bozovic 2016). Common to both perspectives is an assumption that relational contracting is inherently efficient, and the policy imperative is to find ways to allow it to bloom, either by removing obstacles or

cultivating information flows.

The behavior of firms in important markets does not fully reflect those theories, however. Consider, for example, contracting patterns in the biopharmaceutical industry. Substitutionary theory would predict that, if there is a robust network of connections between biopharmaceutical firms, then formal contracting should be less important, consistent with the idea that formal contract enforcement interferes with the maintenance of social norms. Or, if the industry network is sparse, complementarity theory would predict that formal agreements would play a major role, consistent with the claim that formal agreements are used to foster informal governance when it is weak. In fact, we see a different pattern: Parties deeply embedded within the industry network, for whom informal governance is presumably readily available, are *more* likely to employ certain important formal governance mechanisms. Formal contracts are being used when their importance should be diminished. It appears that this positive correlation between formal and informal governance is not isolated to biopharmaceuticals: Bernstein observes a similar pattern in her recent study of equipment supply chains in the American mid-west, where formal contracts and robust network governance are combined (Bernstein 2015).

Why do we observe extensive formal contracting in high social capital exchanges? This Article argues that prior research struggles to answer that question because it overlooks important costs of relational contracting. Conventional relational contract theory assumes that being deeply embedded within a tight collection of market participants is beneficial, because deeper interconnection facilitates repeated dealings and the circulation of reputational information that police opportunism. However, a review of the trade literature and discussions with practitioners in the course of undertaking this study have not revealed widespread concern over such opportunism problems; rather, practitioners emphasize the risk of intellectual property spillovers.[2] In markets such as bio-

[2]As one practitioner interviewed for this project noted, opportunism problems may be salient when partnering with a small biotech start-up with an "idiosyncratic founder," but less so in most settings. Academic research has also found that the threat of hold-up is less of a concern in biopharmaceutical collaborations than contract economics would suggest (G. P.

pharmaceuticals, increasing ties can be problematic in the sense that, as parties become more embedded within a network, patent thickets often form, intellectual property claims to similar technology come into conflict, and appropriating rents from one's assets becomes more difficult (Heller and Eisenberg 1998). The challenges of appropriating rents from one's assets can lead to acquisition waves, such as the jockeying to acquire companies with intellectual property related to RNA interference a decade ago (Schmidt 2007), and a growing literature examines how the limits of intellectual property rights affect firms' make-or-buy decisions (Burk 2004; Burk and McDonnell 2007; Bar-Gill and Parchomovsky 2009). Intellectual property spillovers can also lead to litigation, such as the recent disputes that have arisen over CRISPR gene-editing technologies (Contreras and Sherkow 2017). Dense patent landscapes also create difficult contracting problems, as parties entering an alliance relationship must grapple with the challenge of drawing clear boundaries around the background intellectual property they are licensing to one another, and of developing and prosecuting foreground intellectual property that does not interfere with other aspects of their pipelines (Costalas & Rayski 2011).

Those concerns about spillovers are consistent with research in economic sociology, which has been largely overlooked in the legal literature, that has found that increasing embeddedness also has its downsides. In pioneering work, Uzzi identifies a "paradox of embeddedness," which arises where network ties close one off from new sources of information, leading to stagnating performance (Uzzi 1996; Uzzi 1997).[3] Spillover issues can be understood as a corollary to Uzzi's paradox. More connectivity within the network is a problem, not a solution.

This Article argues that formal agreements may be designed in part to disrupt information flows in transactions that experience those costs of embed-

Baker, Gibbons, and Murphy 2008). See Section 3.1.1 below and (M. Jennejohn 2016) for a fuller discussion of recent research that has identified an array of exchange hazards, in addition to the classic "hold-up" problem, in contracting.

[3]The challenges of greater network embeddedness have become a theme in the practitioner literature, which focuses in part upon designing and managing networks of collaborations (Lloyd et al. 2013).

dedness.[4] Where addressing overembeddedness is a more pressing need than facilitating the diffusion of reputational information, formal contracting plays a greater role in the exchange relationship. There is a trade off between responding to opportunism on one hand and spillovers on the other.

The Article tests that "disruption thesis" by exploring the relationship between social capital and the design of formal contracts in the biopharmaceutical industry. It begins with an introductory case study: A 2011 alliance between Janssen Biotech, Inc. and Pharmacyclics, Inc. for the development of hematological cancer therapies. Both companies had collaborated with each before, and both had extensive portfolios of additional alliances. A careful reading of the formal Janssen/Pharmacyclics agreement and analysis of the context surrounding the deal suggest that key aspects of the formal contract were designed to address spillover concerns consistent with the disruption thesis and inconsistent with conventional relational contracting theory.

The Article then presents the results of a quantitative analysis. Prior research on relational contracting infrequently combines extensive data on contractual relationships in a market with detailed analysis of the formal agreements underpinning those relationships. Instead, relational contracting often has been studied somewhat from a distance—many studies make assumptions with respect to social capital rather than actually operationalizing and measuring it,[5] and many studies rely upon summaries or proxies of contractual characteristics rather than closely analyzing the actual terms of the agreements in question.[6] This paper addresses both limitations by combining a rich topological map of

[4]The term "disrupt" is used here in the sense of redirecting a practice from its trajectory. Of course, the term "disrupt" naturally evokes Christensen's well-known concept of disruptive innovation (Christensen 2013). "Disruption" is used here in a way generally consistent with Christensen's idea, although this paper is not a direct extension of Christensen's theory of how firms can compete successfully in dynamic markets to the realm of legal institutions.

[5]For instance, Gilson et al. and Jennejohn make broad assumptions in their papers that global, highly innovative markets are too dynamic for robust social norms to exist (M. C. Jennejohn 2008–2009; Gilson, C. F. Sabel, and R. E. Scott 2009). Bernstein's recent work is a noteworthy exception (Bernstein 2015), as is sociological research (see, e.g., W. W. Powell, Koput, and Smith-Doerr 1996; Robinson and Stuart 2007b).

[6]For instance, to measure contractual complexity Robinson and Stuart rely upon a word count of the summaries, produced by a third-party data service, of the agreements they study (Robinson and Stuart 2007b). Recent analyses by legal scholars of alliance contracts are an exception (Gilson, C. F. Sabel, and R. E. Scott 2009; Bernstein 2015; M. Jennejohn 2016).

the industry network with highly specific hand-coded data on formal contract characteristics. Specifically, to measure parties' social capital, data on over 33,000 contractual relationships in the biopharmaceutical industry were compiled. That dataset was used to produce two measures of social capital: first, "relational social capital," measured as the number of repeated deals between the parties in the industry; and second, "structural social capital," measured by parties' centrality within the industry network.[7] Data on a variety of contract provisions were then hand-collected for over 500 of the alliance agreements in the dataset.[8] An important term that provides parties with an opportunity to disrupt the trajectory of a collaboration serves as the study's dependent variable: consensus-based joint governance committees in alliance contracts, which typically give both parties to the agreement veto rights with respect to the direction of the research and in regard to the exploitation of the intellectual property resulting from the collaboration.[9]

Regression models are estimated to study the relationship between those two measures of social capital and the use of governance committees. The results of that quantitative analysis provide preliminary support for the disruption thesis. The key findings are summarized as follows.

First, the study finds that, when additional controls are introduced, the parties' combined network centrality, but not the existence of repeated deals, correlates positively and significantly with the incidence of a joint governance committee in an alliance agreement. Thus, a key empirical finding is that the contractual provisions of interest here appear to be responses to parties' structural social capital arising from their positions within an industry network rather than reactions to relational social capital arising from repeated deals. That finding is important because it is inconsistent with a plausible alternative theory, which

[7]The terms "structural" and "relational" social capital are Moran's (see Moran 2005).

[8]The agreements studied here are publicly available as filings with the U.S. Securities and Exchange Commission.

[9]Discussions with practitioners have emphasized the importance of these committees and that their design is typically negotiated and non-standardized. Governance committees have attracted scholarly attention in recent years as researchers have attempted to understand inter-firm collaboration in high technology markets (D. G. Smith 2005; Gilson, C. F. Sabel, and R. E. Scott 2010; J. Reuer and Devarakonda 2015; M. Jennejohn 2016).

is that formal contracting is more extensive in high social capital situations because the increased trust resulting from dense connections within a network makes parties more comfortable with using formal governance mechanisms that are susceptible themselves to opportunistic misuse. That is, a party may not agree to certain formal contract provisions, which an unscrupulous party may use against them, unless it is confident that it can use informal means to constrain that opportunistic use of the term. From this perspective, informal social norms police the boundaries of formal contract terms, which would only be invoked in "acceptable" circumstances. Formal contract terms depend upon trust.[10] However, if trust is a predicate to the use of formal terms, then we would expect repeated dealings between the parties to correlate positively and significantly with the use of governance committees, and yet that is not observed in the results.

Second, the study treats the parties' structural and social capital measures as instrumental variables and studies the interaction of network centrality and prior deals with proxies for various exchange hazards, and it finds that the combination of high network centrality and increased spillover risk correlates positively and significantly with governance committee use. Notably, the analysis also found no statistically significant relationships between the interaction of network centrality and the risk of opportunistic hold-up and governance committee use. Furthermore, the analysis of interaction effects found no statistically significant relationship between the interaction of repeated deals and the exchange hazard proxies and the use of governance committees. Those findings are consistent with the idea that greater network embeddedness exacerbates spillover problems, and that the governance committees established by the formal contracts are responses to them.

[10]This theory has not been widely pursued in the academic literature. Poppo & Zenger refer to this possibility in their important paper (Poppo and T. Zenger 2002), and Macneil alludes to it also in his classic work (Macneil 1977–1978); however, the argument has not received wide attention or been subjected to significant empirical testing. Perhaps the most extensive discussion is found in Bernstein's work (Bernstein 2015), which notes that parties with greater social capital can be more confident that the termination provisions used in the supply agreements she analyzes will not be misused by an opportunistic counterparty.

Taken together, those findings provide preliminary support for the disruption thesis, and they suggest that a basic reset may be necessary with respect to how we conceive of the formal/informal interface in contract design. Of course, a single study is a rather modest basis for a call to refashion relational contracting theory. At the same time, the longstanding research upon which this study builds is too compelling to ignore any longer. Thus, this article outlines the foundation for a new theory of relational contracting, while taking care not to overclaim but to advance in the spirit of opening debate.

The approach outlined here both differs from and partakes of prior theories of relational contracting. The disruption thesis re-purposes substitutionary theory's central insight by arguing that interfering with the information flows upon which informal governance relies is a *purpose* of the formal contract, rather than being an unfortunate and inadvertent *consequence*. Formal interference with informal contracting can be a feature, not only a bug. At the same time, the disruption thesis is reminiscent of complementarity theory: formal agreements compensate for the limits of informal governance. However, the limits of relational contracts and the way in which formal agreements compensate are conceptualized quite differently. In summary, the disruption thesis presents a third way. As discussed further below, this hybrid approach to relational contracting has the potential advantage over prior theories of being both more accurate and more parsimonious.

A normative implication of the disruption thesis is that eliminating forces that destabilize informal information flows, as conventional wisdom would prescribe, may be misguided. Rather, the policy imperative is to balance the tensions between the formal and informal institutions that shape relational contracts.[11] Achieving that balance requires a contingent theory of relational contracting that can answer the difficult question of how parties and policymakers are to know when a formal agreement should support informal governance mech-

[11] Sabel & Simon make an argument in the same spirit for the recognition of "destabilization rights" that allow stakeholders to disrupt dysfunctional public institutions (C. F. Sabel and W. H. Simon 2004).

anisms, when it should disrupt them, and vice versa.

Contingency also requires a fundamental shift in how we conceptualize the key problems in contract design. Contingent infrastructure extends the time horizon of parties' decision-making in the sense that costs may arise as formal and informal institutions are recombined differently from deal to deal. In that respect, contract design begins to resemble a theory of endogenous institutional change more and more. Such a theory is largely absent in the economics of contract design, but the tools for constructing it are within reach. Endogenous theories of change in modern capitalism are a longstanding topic of interest, occupying disciplines such as strategy scholarship (Teece, Pisano, and Shuen 1997; Eisenhardt and Martin 2000; Helfat, Finkelstein, et al. 2009), evolutionary economics (Nelson and Winter 2009), and economic sociology (C. F. Sabel 1993; C. F. Sabel 1994; Stark 1996b; Vedres and Stark 2010; Padgett and W. W. Powell 2012). That diverse literature traces its roots to the Carnegie School (H. A. Simon 1976; March 1959), Schumpeter's classic work on creative destruction (Schumpeter 2013), Polanyi's concept of the "double movement" by which moves toward market liberalization inevitably lead to regulatory responses (Polanyi 2001), and, ultimately, Marx's argument that capitalism's inherently unsustainable internal structure sows the seeds of institutional change (Marx 1926). A common denominator upon which to aggregate that varied scholarship can be found in Stark's differentiation between transaction costs and "transformation costs," the latter referring to the costs of refashioning the institutions that minimize transaction costs (Stark 1996a). Recognizing transformation costs does not displace conventional approaches to economic organization, but rather promises to supplement them with an approach that places institutional dynamism at its core.

The Article unfolds in five parts. Following this introduction, Part 2 introduces the puzzle of formal contracting in high social capital transactions. Part 3 outlines and then empirically tests the disruption thesis through qualitative and quantitative analyses of alliance contract design in the biopharmaceutical

industry. Part 4 discusses the disruption thesis' implications for theories of market infrastructure. Finally, the Article concludes with a discussion of the study's limits and next steps for subsequent research.

2 Relational Contract Theory and Its Limits

Theories of contract design must accomplish two tasks to be persuasive. First, they must accurately describe the hazards affecting transactions. Second, they must describe how the contracts that parties design address those hazards. It is as easy, and as difficult, as that.

This article introduces the disruption thesis into a scholarly field in flux. There is a general consensus, at least among contract economists, that opportunism problems are the primary concern in most exchanges, and researchers have generally agreed on how informal governance operates—repeated exchanges with the same contractual partner or being connected to other firms in a wider industry network discipline market participants through the prospect of losing future business due to opportunistic behavior. There is less agreement, however, on the relationship between formal and informal contracts. The literature is split into two broad categories: those theories that argue that formal and informal contracts are substitutes for one another, and those that argue that formal agreements complement informal contracts.

This section argues that both substitutionary and complementarity theories of relational contracting share a common blindspot. Growing evidence suggests that extensive formal contracting often occurs in high social capital situations, contrary to the expectations of both substitutionary and complementarity theories of the relationship between formal and informal contracts. A positive correlation between formal contracting and social capital suggests that something else is at work, and that yet another iteration of theoretical development is needed to better align relational contract theory with lived market reality.

2.1 The Problem of Contractual Incompleteness

Successfully undertaking many transactions, and particularly those involving the development of complex technologies, demands the ability to coordinate contracting parties' efforts into the future. Plans must be made, and there must be an expectation that those plans will be kept, before investment proceeds. Formal contracts are often considered tools for providing that certainty: modern contract law's vindication of parties' expectation interests in the event of breach provides actors the certainty necessary to engage in significant investments. On the other hand, because parties cannot fully anticipate future events, those formal agreements will be inevitably incomplete and in turn rigid as those events unfold. The inter-firm innovation processes analyzed in this paper are particularly uncertain: Parties often begin collaborations with rough, impressionistic plans, which are then revised as joint discovery progresses (M. C. Jennejohn 2008–2009; Gilson, C. F. Sabel, and R. E. Scott 2009).

Contractual incompleteness can be particularly problematic in situations where investment in relationship-specific assets is required (Klein, Crawford, and Alchian 1978). An exchange requiring such investments—*i.e.*, investments in assets that can be sold in the alternative to third parties only at a material discount—renders that party vulnerable to an opportunistic partner, who, knowing that the investing party is over a barrel, can "hold-up" the investing party as performance unfolds in order to secure a greater share of the contractual surplus (Goldberg 1976; Klein 1996; Hart and Moore 1999). A massive literature known as the Theory of the Firm examines the conditions under which vertically integrating production within the boundaries of a single firm is a more efficient response than arm's length contracts to the threat of hold-up.[12] Gibbons provides an excellent overview of the different theories of the firm and their fundamental assumptions of how economic organization responds to

[12]Coase's seminal paper (Coase 1937) is widely recognized as the origin of this literature, although the specific threat of opportunistic hold-up is conspicuously absent in the piece. Later work would focus the field's attention on hold-up threats (Klein, Crawford, and Alchian 1978; Williamson 1985; Williamson 1996).

echange hazards (Gibbons 2005). Vertical integration is not the only solution to the hold-up problem—informal governance may also compensate for incomplete formal contracts (B. D. Richman 2004).

2.2 Relational Solutions to the Problem of Contractual Incompleteness

Following Simon's early work, it is common to frame the challenge of contractual completeness as a tension between competing needs for certainty—the ability to organize investment upon concrete plans for the future—and flexibility—the ability to adjust those plans to accommodate unforeseen contingencies (H. A. Simon 1951). Informal governance can provide flexibility in two respects: repeated dealings between contracting parties—by which parties accrue "relational social capital"—or the possibility that information regarding the quality of the performance of one's contractual obligations will be shared within the producer community—or parties' "structural social capital"—disciplines parties that might otherwise act opportunistically due to the limits of formal contract enforcement (Moran 2005; Macaulay 1963; Macneil 1977–1978). Since it is the prospect of sanctions being applied in a subsequent transaction due to behavior occurring in an immediate transaction, the key to effective informal governance is what Greif describes as "intertransactional linkage" (Greif 2006, pg. 58). Linking transactions, either through repeated dealings between two parties or through information sharing within an industry network, creates the stability required for consistent norms to emerge (Greif 2006, pg. 59) and allows an aggrieved party to discipline an opportunistic counterparty by terminating the relationship (Bernheim and Whinston 1998; MacLeod and Malcomson 1989; MacLeod and Malcomson 1988; Telser 1980). This informal form of enforcement may be less costly—*i.e.,* more accurate—than formal enforcement because industry players are better able to assess evidence of contractual breach than courts, and game theoretic models show that rational parties will employ relational contracts in lieu of formal enforcement where the contracting parties

have better information than a third party enforcer (see, e.g., Bull 1987).

If informal governance plays a significant role in an industry, then a natural question is how those informal institutions interact with formal contracts, which often also persist in some form in markets where relational contracting occurs. Debate on this topic has centered upon whether formal and informal institutions are substitutes or complements for one another. Early research took the substitutionary position, arguing that contracts can be "self-enforcing" by virtue of informal constraints, and, in turn, formal contracting may "crowd out" those efficient social norms (Kranton and Swamy 1999; Gneezy and Rustichini 2000; Trebilcock and Leng 2006). Crowding out may occur, because formal agreements may signal distrust of one's partner (Dyer and Singh 1998; R. Gulati 1995; Macaulay 1963). Formal enforcement may also interfere with informal governance because the "contextualist" interpretive doctrines found in the Uniform Commercial Code and Restatement (Second) of Contracts, which encourage courts to consider extrinsic evidence—such as trade usage, course of dealing, and course of performance—are prone to misread informal commercial practice (Bernstein 1999; R. E. Scott 2003).[13] For that reason, some argue that the minimalistic intervention of traditional common law formalism is more appropriate for resolving disputes arising from relational contracts (Schwartz and R. E. Scott 2003).[14] The substitutionary thesis is supported by empirical studies, which have found evidence of parties eschewing formal agreements in

[13]The difficulty of correctly identifying trade usages can have the ironical effect of discouraging the very flexibility that contextualism is meant to accommodate: a temporary deviation from the letter of a contract can be interpreted as a permanent renunciation of a formal term, penalizing parties for engaging in relational adjustment (Bernstein 1999; R. E. Scott 2003).

[14]Self-Enforcement does not necessarily mean that formal contract terms are irrelevant. Klein argues that transacting parties use formal contracts in tandem with informal constraints to police hold-up problems (Klein 1996). According to Klein, transacting parties write their formal contracts to address only hold-up problems of such magnitude that they fall outside of a "self-enforcing range" policed via informal constraints (Klein 1996, pg. 455). The parties' respective amounts of social capital determines that "self-enforcement range" in an exchange (Klein 1996, pg. 449-50). Formal contract terms then expressly set the bounds of that range, and they are used sparingly because formal obligations, which are unavoidably incomplete, present opportunities themselves for hold-up – *i.e.*, via litigation of ambiguous terms (Klein 1996, pg. 455). Informal enforcement is understood to not present such opportunities for hold-up through litigation (Klein 1996, pg. 449), and so, if social norms are sufficiently potent, Klein presumes that parties will opt for informal governance instead of formal. In that respect, formal and informal contracts are used in tandem, but they are ultimately substitutes for one another – *i.e.*, one does not deploy formal governance where informal will suffice.

favor of informal governance (Robinson and Stuart 2007a; Robinson and Stuart 2007b).

In recent years, researchers have begun articulating an alternative theory: that formal and informal contracts are complements, rather than substitutes, to one another. The complementarity thesis' fundamental claim is that formal and informal contracts can work together in the sense that formal agreements can reduce the severity of exchange hazards, and informal governance can fine-tune incentive setting. This argument has its roots in Goetz & Scott's work, which envisions certain key formal contract terms, such as best efforts provisions, as tools for relational contracting (Goetz and R. E. Scott 1981), and in theoretical work by Baker, Gibbons & Murphy, which demonstrates that, in certain situations, an optimal incentive contract includes (1) an objective performance measure (which is necessarily imperfect), and (2) an informal understanding regarding how that objective performance measure is rewarded, which serves to moderate the distortions arising from the imperfections in the formal agreement (G. Baker, Gibbons, and Murphy 1994). Empirical studies have found evidence supporting the complementarity thesis (Poppo and T. Zenger 2002; Mayer and Argyres 2004).

By its nature, the complementarity thesis demands a more detailed and, in turn, unavoidably complex analysis of how specific formal contract terms interact with informal governance. A high level of detail is required because there is a wide variety of formal contract terms employed in contemporary practice, and presumably they have the potential to interact in different ways with informal governance mechanisms. As a result, legal scholars have begun diving into the details of contract design, focusing primarily on the use of certain formal contract terms in technology markets characterized by high uncertainty (Dent 2002; D. G. Smith 2005; M. C. Jennejohn 2008–2009; Gilson, C. F. Sabel, and R. E. Scott 2009; Geis 2010; Gilson, C. F. Sabel, and R. E. Scott 2010; Hadfield and Bozovic 2016; Blair, O'Hara O'Connor, and Kirchhoefer 2011).

The starting point for much of this scholarship is the assumption that the

dynamism of modern technology markets undermines attempts to govern inter-firm collaboration informally—markets are too far-flung and subject to change for social capital to accrue (M. C. Jennejohn 2008–2009; M. Jennejohn 2016; Gilson, C. F. Sabel, and R. E. Scott 2009; Gilson, C. F. Sabel, and R. E. Scott 2010; Hadfield and Bozovic 2016). Two theories working in this vein stand out. In a series of papers, Gilson, Sabel & Scott (Gilson, C. F. Sabel, and R. E. Scott 2009; Gilson, C. F. Sabel, and R. E. Scott 2010; Gilson, C. F. Sabel, and R. E. Scott 2013) argue that, in situations where social capital is low, particular types of provisions in formal contracts can approximate the rich information sharing necessary for informal governance to operate. They argue that, in high uncertainty environments, specialized formal contract provisions can create the information exchanges and switching costs necessary to informally police hold-up problems, and in that sense formal contracts "braid" with informal governance mechanisms (Gilson, C. F. Sabel, and R. E. Scott 2010). Such Braiding mechanisms (1) require both parties to invest in relationship-specific information and structure that investment through adaptation protocols, such as formal plans, process guidelines, and co-design requirements, (2) include a "contract referee" device, such as a committee with unanimous decision making process and a dispute escalation process, which is understood as tool for revealing information symmetrically between the parties, (3) force parties to invest in relationship-specific information, thereby raising their switching costs (*i.e.*, the cost of replacing a counterparty), which acts as a further constraint on opportunistic behavior; and (4) reveals whether one's counterparty is cooperative or acts opportunistically (Gilson, C. F. Sabel, and R. E. Scott 2009; Gilson, C. F. Sabel, and R. E. Scott 2010).

Hadfield & Bozovic (Hadfield and Bozovic 2016) introduce another theory, which argues that formal contracts act as "scaffolding" for informal contracts by providing a benchmark by which the parties determine whether a breach has occurred. That benchmark is not used by a third party tribunal to enforce the contract, as envisioned under classical contract law, but is rather used by the

parties themselves to calibrate their informal enforcement tools. Based on a series of structured interviews, Hadfield & Bozovic find that such formal Scaffolding is important in high uncertainty environments, because the formal contract "reduc[es] the collective ambiguity about what constitutes breach" in situations where industry norms are inconsistent (Hadfield and Bozovic 2016). In certain respects, the Scaffolding argument is similar to Braiding: both see trust emerging endogenously within the exchange relationship, with formal contracts playing a pivotal role in shaping information processing between the parties to the agreement. In the Scaffolding model, informal constraints' efficacy grows as the parties proceed under the contract, referring consistently to the written agreement to inform their observations of one another's performance. In the Braiding model, informal constraints grow efficacious as the formal information revelation system renders performances observable and increases switching costs. The approaches differ, however, in that policing opportunism in the Scaffolding model does not depend upon third party enforcement, unlike Braiding, which gives a role—albeit a minimalistic one—to courts.

2.3 The Puzzle of Extensive Formal Governance in High Social Capital Transactions

In summary, the scholarship introduced above advances two theories. Substitutionary theories of relational contracting argue that formal contracting should be minimal when social capital is high. Complementarity theories add a corollary: in those situations where social capital is low, formal contract terms can be used to foster informal governance.

An important recent study by Bernstein (Bernstein 2015) complicates the theoretical landscape by identifying a puzzling phenomenon. Using data from Whitford's study of collaboration among heavy equipment suppliers in the upper Midwest of the United States (Whitford 2005), Bernstein finds evidence that deals *do* frequently repeat and reputational information *does* diffuse readily through the market. Bernstein provides a nuanced theory of how the industry

network interacts with the bilateral reputational sanctions available through relational social capital to govern exchanges. In a certain respect, her argument is reminiscent of the complementarity theories discussed above. She focuses upon certain formal arrangements, such as supplier qualification programs at the start of a relationship and ongoing supplier training and "scorecard" assessment systems, as tools for addressing coordination problems (Bernstein 2015, pp. 578-86). Those arrangements clarify the differences between innocent mistakes and opportunistic behavior, and thereby build relational social capital between the parties. In that sense, Bernstein's argument that formal governance frameworks "promote the growth of trust-based relationship-specific social capital" (Bernstein 2015, pg. 589) echoes the Braiding and Scaffolding theories, although the formal mechanisms upon which she focuses differ.

However, Bernstein's argument also departs from prior research in an important respect. In regard to structural social capital, she argues that the multilateral reputation effects available when parties are embedded within an industry network can make the bilateral sanctions available when deals repeat more powerful. Augmenting relational social capital broadens the self-enforcing range of contractual obligations, because network governance is able to police opportunistic behavior that is neither observable nor verifiable (Bernstein 2015, pp. 601-03). One way to understand Bernstein's point is that structural social capital, which prior research has often overlooked, exists and complements relational social capital just as formal contracts can complement relational social capital. Her paper leaves open the question, however, of how formal contract and structural social capital interact in such situations. In that respect, Bernstein sets the stage for this study, the results of which are discussed in the next section.

3 Theory and Evidence of Disruptive Formal Contract Terms

The patterns identified in Bernstein's recent work, which also appear in the sample of biopharmaceutical alliances analyzed below, are puzzling. We see extensive formal contract terms being used in high social capital situations, which is inconsistent with both substitutionary and complementarity theories of relational contracting. Why include extensive formal governance mechanisms where social capital appears so high?

This section of the article argues that prior research struggles to answer that question because it overlooks important costs of relational contracting. While conventional relational contract theory assumes that being deeply embedded within a tight collection of market participants is an invariable benefit, research in economic sociology has found that increasing embeddedness has its downsides. A problem arises when ties among members of a network become increasingly redundant. Even as connections increase, redundancy can close one off from new sources of information, leading to stagnating performance, a problem which Uzzi refers to as "the paradox of embeddedness" (Uzzi 1996; Uzzi 1997). In highly innovative markets, such as biopharmaceuticals, redundancy can also be problematic in the sense that, as parties become more embedded within a network, patent thickets often form and intellectual property claims to similar technology come into conflict (Heller and Eisenberg 1998). In those respects, more connectivity within the network is not an unalloyed good.

The tension between the benefits and costs of relational contracting provides a simple explanation of the puzzle of extensive formal contracting in high social capital situations. Formal agreements may appear unnecessary to police opportunism when social capital is high, but they are nevertheless useful to disrupt information flows in transactions that are overembedded in the sense introduced above. In short, where addressing overembeddedness is a more pressing need than facilitating the diffusion of reputational information, formal contracting

plays a greater role in the exchange relationship.

This Part of the Article presents a theory of relationally disruptive formal agreements. Included in that discussion is a case study of the alliance relationship between Janssen and Pharmacyclics, which illustrates the theory and provides concrete context for the quantitative analysis that follows. That quantitative analysis examines the design of over 500 alliance agreements in the biopharmaceutical industry, and the results provide initial support for the disruption thesis.

3.1 A Theory of Disruptive Formal Agreements

As mentioned in the introduction of Part 2 above, a successful theory of contract design must describe the exchange hazards parties face, and then how parties design contracts to address those hazards. This sub-section's first move is to expand the menu of exchange hazards beyond contract economics' focus on opportunistic hold-up. The focus here is upon potential hazards identified in prior research: appropriability, or "spillover," problems; and coordination, or "entropy," problems. Expanding the menu of exchange hazards raises the possibility that informal relationships may do more than convey reputational information, and so this sub-section's second move is to introduce the "paradox of embeddedness" identified by Uzzi (Uzzi 1996; Uzzi 1997).

This sub-section then outlines a new theory of the relationship between formal and informal contracts. The argument begins with the premise that formal contracts are designed, in part, to address these newly identified costs, rather than simply to respond to opportunism problems. Contracts are "multivalent" in the sense that they respond to more than one type of exchange hazard (M. Jennejohn 2016). This creates a tension, because formal mechanisms designed to address spillover and/or entropy problems may interfere with the use of reputational constraints to police hold-up problems. Therefore, we would expect to see formal contracts used to address appropriability and coordination problems where parties are more embedded within the industry network.

Finally, this sub-section concludes with discussion of the 2011 Janssen/ Pharmacyclics alliance, which serves as an illustrative case study demonstrating elements of the disruption thesis. Both Janssen and Pharmacyclics are deeply embedded within the industry network, and the alliance agreement shows the two parties using formal governance mechanisms to address an array of appropriability problems. This case study is meant to build intuition for the quantitative analysis that follows.

3.1.1 Multidimensional Exchange Hazards

Perhaps the best place to begin answering the puzzle of extensive formal contracting in high social capital transactions is Granovetter's classic article on socially-embedded exchange (Granovetter 1985). One implication of Granovetter's paper, which is a wide-ranging commentary on the study of economic organization in both economics and sociology, is that social networks can serve as conduits for multiple types of information.[15] That point has yet to be incorporated into the mainstream of contract economics, which is preoccupied with the problem of opportunistic hold-up threats that arise where a transaction requires relationship-specific investment (Williamson 1985).

Consistent with Granovetter's core insight, however, recent research outside of contract economics has demonstrated that collaborators often face multiple types of hazards. First, a growing body of research in intellectual property provides evidence that companies in high technology markets are often responding to the risk that imperfect property rights in proprietary technical information will lead to one's technology spilling over to others in the market (Bar-Gill and Parchomovsky 2009; Burk 2004; Burk and McDonnell 2007). That appropriability problem can be acute even without an element of opportunism: parties are frequently concerned that the counterparty to whom important technology has been licensed will collaborate with or be acquired by a competitor in the

[15]This multidimensionality is seen in its simplest form in Granovetter's point that informal connections can transmit falsehoods just as easily as accurate reputational information (Granovetter 1985).

future, raising the possibility that the competitor will gain access to that technology (Weisburd et al. 2010). Second, coordination, or "entropy," costs can arise as parties struggle to sync joint learning processes across firm boundaries.(M. Jennejohn 2016). Such entropy costs are typically considered mundane in traditional contractual settings, but they can become significant when complex technologies are being developed across organizational boundaries (Whitford 2005; J. J. Reuer and Ariño 2007; Mayer and Salomon 2006; Helper, MacDuffie, and C. Sabel 2000; Freeland 2000; Casadesus-Masanell and Spulber 2000; Coase 2000).

Recognizing that exchange hazards are multidimensional introduces the possibility of tensions between responses to different exchange hazards. There may be trade-offs, for instance, between a provision's ability to address a hold-up threat and its ability to control spillover problems. Industry networks can serve as conduits for not only reputation information that constrains opportunism but also leakage of proprietary data. In that respect, contract terms—both formal and informal—are multivalent in that they interact with a combination of hazards, not just the hold-up problem upon which contract economics tends to focus (M. Jennejohn 2016).

3.1.2 The Paradox of Embeddedness

Expanding the menu of exchange hazards requires us to think more carefully about how relational contracting interacts with those hazards. If social capital is only a tool for constraining opportunism, then the more of Greif's "intertransactional linkages" the better. Opportunism is policed as greater relational and structural social capital increases the potency of reputational sanctions, either through a tangible expectation of a future transaction with one's counterparty or as information diffuses readily through the industry network.

But research suggests that the benefits are not so clear. In a study of the New York garment industry, Uzzi finds evidence that socially embedded ties are useful for building the trust that minimizes opportunism, facilitating fine-

grained information transfer, and creating joint problem solving arrangements (Uzzi 1996; Uzzi 1997); however, Uzzi also found that market participants that had socially embedded ties, rather than arm's-length deals, with other market participants, who had many of the same relationships, performed poorly compared to participants with a mix of embedded and arm's-length contractual arrangements. That is, being closely connected to market players which have exchange networks similar—or "isomorphic"—to one's own undercuts performance. Uzzi argues that this finding can be explained by the fact that being densely embedded in a network with many redundant ties reduces the flow of novel information, because few of the market players have unique connections (Uzzi 1997, pp. 58-19). Isomorphism between participants' immediate networks leads to the ossification of information within the broader industry group—collaborations fail due to a "paucity of competence" instead of a surfeit of opportunism (Schrank and Whitford 2011). In many high technology industries, redundant connections can also be problemmatic in the sense that parties may have overlapping intellectual property portfolios. Patent "thickets" form (Heller and Eisenberg 1998), making it difficult to fully appropriate the rents arising from the intellectual property one developed through R&D investment. In summary, increasingly socially embedded exchange presents a paradox: on one hand it is beneficial as a transmission system for reputation information, while on the other hand, at a certain point, it can contribute to spillover problems, becoming too much of a good thing, so to speak.[16]

[16]In its essence, the paradox of embeddedness is similar to the lock-in problem that arises from the standardization of formal contract terms. Standardization of formal terms can be used to address common exchange hazards across similar deals, which reduces mundane drafting costs and sends a quality signal (Klausner 1995; Kahan and Klausner 1996; Kahan and Klausner 1997), which in turn may free up resources to fine-tune portions of the agreement addressing novel contingencies. However, as recent research on the *pari passu* clause in sovereign debt indentures has demonstrated (M. Gulati and R. E. Scott 2012; Choi, M. Gulati, and R. Scott 2016), contractual standardization also has a darkside. Terms standardized across a market can become locked-in as transaction designers reap increasing returns to scale, as parties come to view deviations from the market standard as signals of non-sophistication, or as the original meaning of a term becomes lost to memory. In short, standardized provisions can become stuck in the rut of collective action problems, and in that respect there is a common foundation to the paradox of embeddedness and boilerplate lock-in.

3.1.3 Relationally Disruptive Contract Terms

Might formal contracts be used to address the paradox of embeddedness? Strategy research suggests such a possibility. Using an experimental research design, Lazzarini et al. find evidence that formal contracts augment parties' ability to break free from overembedded exchanges and establish ties with new trading partners (Lazzarini, Miller, and T. R. Zenger 2008). In their study, the existence of a formal contract makes a party more likely to sever an existing relationship when the value differential between the party's current deal and an alternative transaction increases (Lazzarini, Miller, and T. R. Zenger 2008, pg. 719). The theory presented here builds upon the basic intuition underlying their finding, extending it through a more detailed analysis of how formal contracts are designed to respond to overembeddedness and by adding greater emphasis on the multidimensional exchange hazards collaborators often face.

Recognizing the costs of relational contracting provides a simple explanation of the puzzle of extensive formal contracting in high social capital situations. Formal agreements may appear unnecessary to police opportunism when social capital is high, but they are nevertheless useful to control and even disrupt the flow of technical information within an industry network. That disruption may be useful for addressing spillover problems. For example, with respect to spillovers, the role of some types of formal contract terms, such as confidentiality obligations, in restricting blatant information misappropriation, such as a counterparty running off with one's technology, is fairly obvious. However, alliance contracts also include intellectual property provisions that address the more subtle problem of a company's counterparty entering into third party agreements—such as licensing arrangements, alliances, or change of control transactions—or pursuing patent prosecution strategies that affect the first company's ability to exploit its own intellectual property. Alliance agreements then often include governance mechanisms that can control spillovers as the alliance proceeds. For instance, a consensus-based joint governance committee gives a party the ability (1) to steer a collaboration in a direction that will avoid conflicting with

other areas of that party's technological portfolio; (2) to veto decisions regarding the definition and prosecution of foreground intellectual property rights that may interfere with other aspects of its technological portfolio; and (3) to veto a counterparty's attempt to transfer jointly-owned foreground intellectual property, which under US law allows a co-owner to license the jointly-owned patent without the permission of the other co-owner (M. Jennejohn 2016). In summary, a combination of affirmative promises—such as promising not to misappropriate trade secrets—are coupled with administrative mechanisms, which allow parties to effectively stall an alliance's progress.

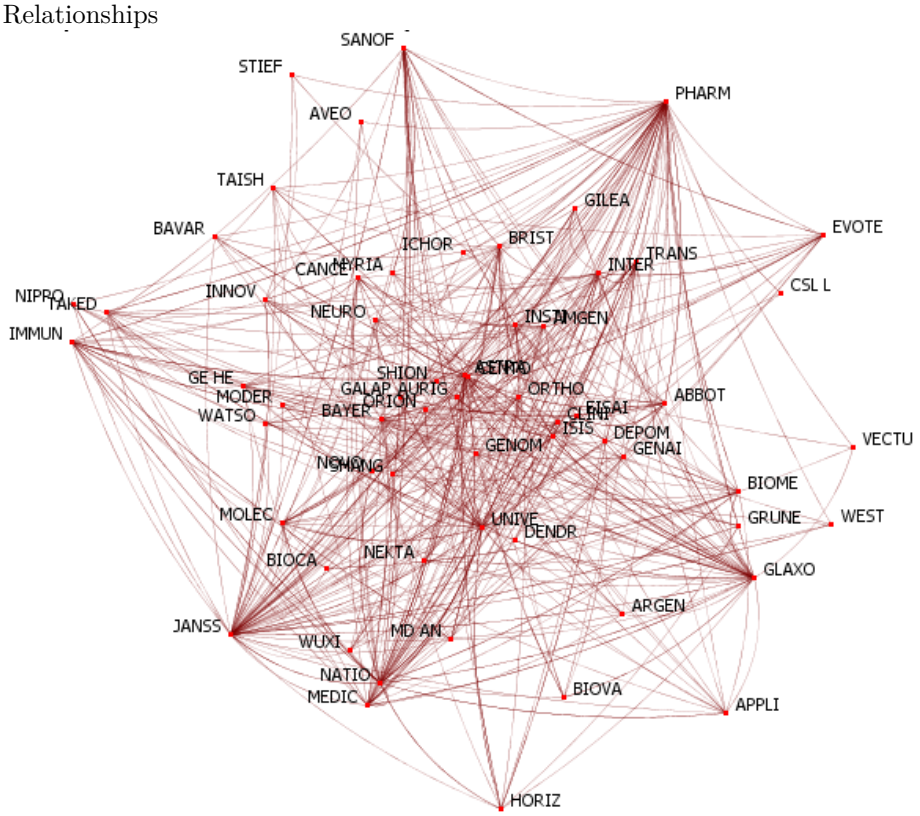
Of course, as they address such spillover concerns, those formal mechanisms interfere with the flow of reputational information. The use of such provisions therefore turns upon the trade-off between the benefits of reputational information diffusion and the costs of technical information diffusion. Formal agreements play a greater role where the latter outweigh the former.

3.1.4 Illustrative Case Study

For an example of how collaborators use formal agreements to address spillover and entropy concerns, consider a 2011 alliance between Janssen Biotech, Inc., a subsidiary of Johnson & Johnson, and Pharmacyclics, Inc. for the development, manufacturing, and commercialization of a drug that eventually came to be known as Imbruvica, a Bruton's tyrosine kinase inhibitor designed to treat hematological cancers such as leukemia and lymphoma. Pharmacyclics brought promising research on a number of compounds to the deal, and Janssen brought the experience and resources necessary to develop and commercialize those compounds into successful drugs. Janssen paid Pharmacyclics an upfront payment of $150 million at the beginning of the collaboration, and Pharmacyclics had the potential to earn an additional $825 million if development and regulatory milestones were met (Pharmacyclics 2011). Following regulatory approval, profits would be split 50/50 as the companies co-commercialized the drug resulting from the alliance (id.).

Janssen and Pharmacyclics were deeply embedded in the industry network. Figure 1 below depicts the network of collaborations in which Janssen and Pharmacyclics operated at the time the 2011 agreement was executed.[17][18] Only companies that had immediate relationships with Janssen and Pharmacyclics are depicted in the network, which includes 61 firms and 588 contractual relationships. The parties had also dealt with one another before, with two prior deals before their 2011 collaboration.

Figure 1: Network Graph of Janssen's and Pharmacyclics' First Degree Alliance Relationships



With both companies participating in a large number of alliances, the likelihood of technological spillovers was significant. By the time the alliance was

[17] In Figure 1, Janssen ("JANSS") is found in the lower left hand quadrant, and Pharmacyclics ("PHARM") is in the upper right quadrant.

[18] Analysis and visualization of the Janssen and Pharmacyclics alliance relationships, and of the broader network of contractual relationships in the biopharmaceutical industry discussed below, were accomplished with version 3.0.9.9.33 of the ORA-Netscenes software developed by researchers at Carnegie-Mellon and Netanomics.

entered into in 2011, Janssen's parent company, Johnson & Johnson, was two years into a new R&D strategy that emphasized increased collaboration with companies with early stage drugs under development (Garde 2013). That strategy involved identifying promising disease targets and then assembling a broad portfolio of collaborations with relevant drugs under development, rather than focusing on a small number of partners (Garde 2014). While most large pharmaceutical companies at the time were realizing about one-third of their discoveries from a collaboration with an external partner, Johnson & Johnson was realizing 50 percent (Garde 2014). That strategy raised the possibility that Janssen would collaborate with one of Pharmacyclics' competitors or bring in additional collaborators that would further complicate Pharmacyclics' ability to fully appropriate the value of its technology.[19] The alliance also presented spillover risks for Janssen. By 2010, Pharmacyclics' Imbruvica drug was promising, which made it an attractive collaboration target. Both Novartis and Celgene competed against Janssen for the alliance with Pharmacyclics in 2011 (Garde 2014), which put Janssen on notice that, so long as clinical trials progressed well, Pharmacyclics would eventually be an attractive acquisition target, and that it would likely continue collaborating with respect to other drugs under development in its pipeline. Indeed, in 2014, Johnson & Johnson lost an intense bidding war with AbbVie for the acquisition of Pharmacyclics (Fontanella-Khan, Massoudi & Hume 2015). While Janssen pledged to continue working with Pharmacyclics, collaboration would raise some complications since AbbVie had been co-developing a competing cancer drug, venetoclax, with Roche (Rockoff & Loftus 2015).

The Janssen/Pharmacyclics alliance agreement[20] includes a number of provisions that appear designed to address such issues. For instance, the contract

[19]For instance, Janssen had a collaboration with Gilead Sciences, Inc., which had a drug under development similar to Pharmacyclics' cancer treatment Imbruvica, relating to HIV (Gilead 2014). Janssen also brought in AstraZeneca (Johnson & Johnson 2014) and Bristol Myers Squibb (Bristol Myers Squibb 2014) to collaborate on the clinical trials of Imbruvica with respect to particular treatment targets.

[20]The full title of the contract is the Collaboration and License Agreement by and between Pharmacyclics, Inc. and Janssen Biotech, Inc. (Nov. 8, 2011). A copy of the agreement and a summary term sheet is available at [SSRN link].

included several pages of provisions carefully controlling the sharing of proprietary information between the companies, and limiting both Janssen's and Pharmacyclics' ability to undertake projects outside the collaboration's field of research.[21] In the agreement, Pharmacyclics also warrants that it has provided Janssen the opportunity to review all of the contractual documentation for other alliances Pharmacyclics had entered into at the time.[22] The agreement also provides that, if either Janssen or Pharmacyclics acquire rights to a competing product, they must either divest the rights in that product related to the collaboration's field of research or include the acquired product within the collaboration's field of research, bringing the product within the remit of the agreement, which then requires the benefits to be shared.[23] Subcontracting for particular development activities was allowed, but entering into "material subcontracts" was subject to counterparty approval.[24] Boundaries between solely-owned and jointly-owned foreground intellectual property were established, the agreement carefully allocated options to each party with respect to prosecuting foreground patents, and the parties were allocated rights with respect to enforcing foreground patent rights against alleged third party infringers.[25] Interestingly, each party is given the option to prosecute its counterparty's solely-owned patents where the counterparty elects not to prosecute, a nice illustration of the agreement addressing the situation where a problem arises for Party A from Party B's patent portfolio.[26] Relatedly, one of the parties (the exact identity is redacted, but it is likely Janssen) is given the initial right to enforce not only jointly-owned but also both parties' solely-owned foreground intellectual property against alleged third party infringers, with the second party given the option to enforce if the first elects not to do so, which is again consistent with the idea that a company's ability to appropriate rents from its assets depends in part on the disposition of the intellectual property of the neighboring companies to which it

[21] Janssen/Pharmacyclics Collaboration Agreement, Sections 3.3 - 3.6.
[22] Janssen/Pharmacyclics Collaboration Agreement, Section 10.6
[23] Janssen/Pharmacyclics Collaboration Agreement, Section 3.7.
[24] Janssen/Pharmacyclics Collaboration Agreement, Section 4.3.2(c).
[25] Janssen/Pharmacyclics Collaboration Agreement, Sections 8.1 - 8.3.
[26] Janssen/Pharmacyclics Collaboration Agreement, Section 8.2.

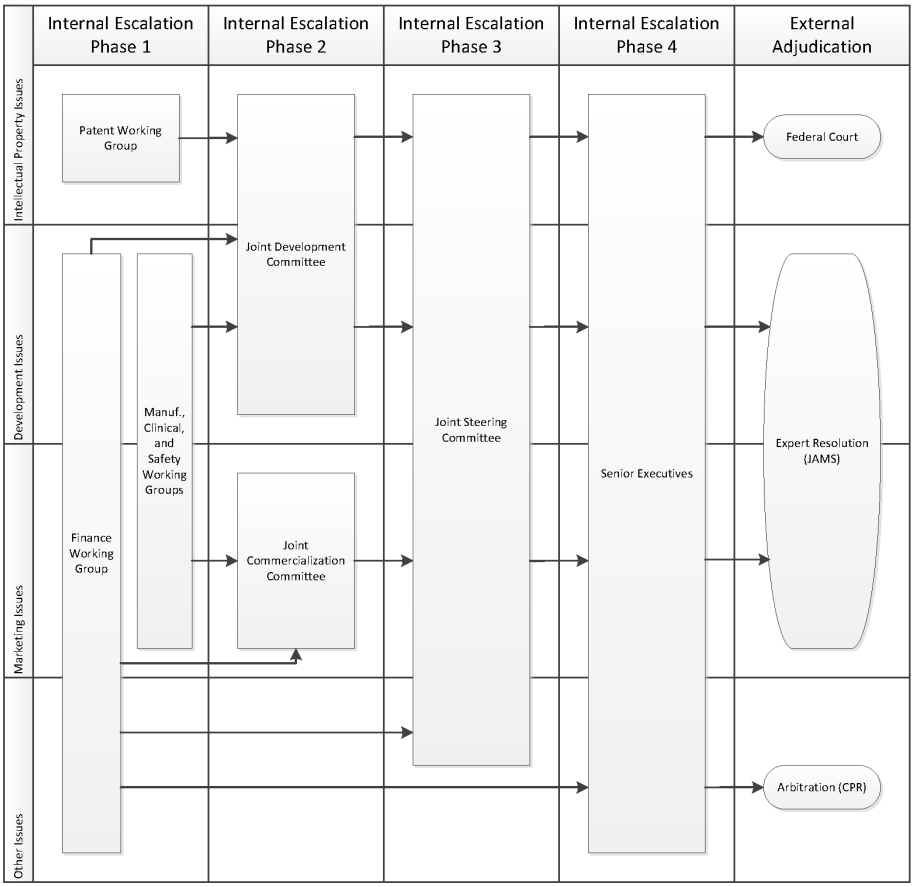
is connected.[27] Finally, if Pharmacyclics undergoes a change of control transaction with an acquirer that "competes significantly" with Janssen, then a number of firewall protections are to be introduced in order to protect the secrecy of Janssen's proprietary information.[28]

Overseeing the entire collaboration was a governance committee, designated the "Joint Steering Committee," which was comprised of equal number of Janssen and Pharmacyclics representatives, and which was required to make decisions according to consensus.[29] That committee system structures information sharing between the parties, cabining information flows as much as it facilitates them. Aspects of the governance committee system expressly reflect the spillover concerns discussed above. The Joint Steering Committee was tasked with developing and approving the Global Development Plan, designing a regulatory strategy, approve subcontracted activities, design a commercialization plan, and resolving impasses within the various subcommittees established by the agreement.[30] Those subcommittees include a Joint Development Committee, a Joint Commercialization Committee, a Manufacturing Working-Group, a Finance Working Group, a Patent Working Group, a Clinical/Regulatory Working Group, and a Safety Working Group, all of which were required to make decisions by consensus.[31] An approximation of the process by which information was reported and disputes escalated in the committee system is represented in Figure 2 below.[32] The consensus-based decision rule also gives the parties multiple veto points at which they can halt the collaboration's progress. Those veto points are available both at a granular level, in the various sub-committees, and

[27] Janssen/Pharmacyclics Collaboration Agreement, Section 8.3.
[28] Janssen/Pharmacyclics Collaboration Agreement, Section 14.2.
[29] Janssen/Pharmacyclics Collaboration Agreement, Section 2.1.1.
[30] Janssen/Pharmacyclics Collaboration Agreement, Section 2.1.
[31] Janssen/Pharmacyclics Collaboration Agreement, Sections 2.2 - 2.6.
[32] From the available data, Janssen's approach to governance committee design does not appear to be standardized. For instance, a 2013 Collaboration Agreement and License Option between Janssen and Capricor, Inc. includes a single consensus-based governance committee, rather than the multi-tiered committee structure employed in the Janssen/Pharmacyclics contract. A 2014 agreement between Janssen and Minerva Neurosciences had three committees. A 2013 agreement between Janssen and Idenix, Inc. includes two governance committees. A 2009 agreement between Janssen and NVPPD Therapeutics had a single committee. A 2006 agreement between Janssen and NV Vertex Pharmaceuticals had four committees.

also at a relationship-spanning level, in the joint steering committee. If a party sees the alliance headed in a potentially problematic direction, it has contractual rights that allow it to affect the collaboration's course.

Figure 2: Process Diagram of the Janssen and Pharmacyclics Alliance's Internal and External Governance System



3.2 Quantitative Analysis

The Janssen/Pharmacyclics case study suggests that key provisions in formal contracts may be used to address the spillover costs of collaboration, rather than preventing hold-up. In doing so, the formal agreements may disrupt the information flows upon which informal governance of opportunism relies. This sub-section tests the disruption thesis on a sample of over 500 collaboration agreements in the biopharmaceutical industry to determine whether the pat-

terns observed in the Janssen/Pharmacyclics case also appear more widely. The preliminary evidence resulting from the analyses supports the disruption thesis, and also introduces new questions to be addressed in subsequent research.

3.2.1 Research Design and Hypotheses

Testing the disruption thesis in a contracting environment as complicated as biopharmaceutical collaborations requires sustained empirical research beyond the scope of a single paper or methodology. Most biopharmaceutical collaboration agreements are highly complex latticeworks of governance mechanisms and often number into the hundreds of pages (Villaneauve et al. 2008). Methods for mapping contractual complexity are progressing (see Ganglmair & Wardlaw 2017; Jennejohn 2018a, 2018b), and studying these agreements in their entirety is an important task for future research. This article therefore takes a more incremental step. At this preliminary stage, focus is isolated to a key governance mechanism in a biopharmaceutical alliance—joint governance committees—and the analysis of additional terms is deferred to later research.

This study's central question is whether relational social capital and structural social capital correlate differently with the incidence of governance committees. The difference between relational and structural social capital is interesting because the spillover costs outlined above are primarily a function of greater network embeddedness, and not repeated dealings. Support for the disruption thesis will be found if structural social capital, measured as the centrality of the contracting parties in the industry network, correlates positively and significantly with the use of joint governance committees and at will-termination provisions, and if relational social capital, measured as prior deals between the parties to an agreement, has no significant correlation with the formal contract terms examined here. If, however, both relational and structural social capital correlate positively and significantly with the use of governance committees and convenience termination, then an alternative theory—that high social capital is a pre-requisite to the use of terms prone to opportunistic misuse—may better

explain the patterns in the data.[33] The specific hypothesis testing the disruption thesis by examining the main effects of relational and structural social capital on governance committee use is as follows:

H1: Joint governance committees are used more often as the parties' combined centrality measures increase, and their use does not correlate with the parties having had a prior deal.

Second, interaction effects between the parties' network centrality and various exchange hazards are also studied. In this part of the analysis, parties' network centrality is treated as an instrument, and correlations are examined to see whether governance committees or convenience termination provisions are used more frequently when higher centrality combines with the presence of an exchange hazard. Specifically, interactions between network centrality and four exchange hazards are examined: hold-up, spillovers, entropy, and "contractibility." The latter is a measure of uncertainty's effect on parties' ability to allocate risks with a formal agreement—contractibility is greater where uncertainty is manageable and parties are able to identify and allocate risks in a formal agreement and lower where uncertainty is significant and parties cannot reduce risks to contractual terms (Lerner and Malmendier 2010). Evidence of interaction effects between network centrality and spillover risks supports the disruption thesis, which, as discussed above, provides an explanation of how increasing embeddedness exacerbates those risks. Evidence of interaction effects between network centrality and hold-up supports the alternative argument that formal terms are used when social capital is high, because greater social capital polices the opportunistic invocation of costly contractual provisions. The specific hypotheses are as follows:

[33]If the study reveals other relationships, the results are somewhat more difficult to interpret, due to the similarities in the substitutionary and complementarity theses. For instance, evidence that both relational and structural social capital correlate negatively and significantly with the use of joint committees and at will-termination would support the substitutionary thesis, although it is also consistent with Gilson et al.'s braiding theory.

H2a: Joint governance committees are used more often when parties with high combined network centrality provide for joint ownership of foreground intellectual property in their alliance agreement.

H2b: Joint governance committees are used more often when parties with high combined network centrality order task interdependencies sequentially in the alliance agreement.

H2c: Joint governance committees are used more often when parties with high combined network centrality engage in multistage deals.

H2d: Joint governance committees are used more often when parties with high combined network centrality engage in deals where only the R&D partner exclusively licenses background intellectual property.

3.2.2 Data Collection and Sample

The data collected for this study fall into two categories. First, data on alliance relationships were collected to construct a map of the network of collaborating biopharmaceutical companies (the "Biopharmaceutical Alliance Network"). Data for the Biopharmaceutical Alliance Network were primarily collected from Clarivate Analytics' Cortellis database, which compiles alliance data from SEC filings, news accounts, press releases, and submissions from market participants.[34] Those data collected from Cortellis were supplemented with unique data from Thomson Reuters' SDC Platinum Joint Ventures/Strategic Alliances database, and hand-collected data from Bloomberg's and LexisNexis's respective EDGAR Filings databases. To construct the Biopharmaceutical Al-

[34]Clarivate Analytics' Cortellis database was originally known as Recombinant Capital, which was later acquired by Thomson Reuters and rebranded as "Recap" and subsequently sold to Clarivate.

liance Network, all databases were searched for collaboration, co-development, license, joint venture, manufacturing, and research agreements designated as falling within SIC code 2834 between 1994-2015. Table 1 summarizes the number of transactions collected from each database.

Table 1: Alliance Data by Source

Source	**No. of Alliances**
Clarivate Analytics Recap	30,422
Thomson Reuters SDC Platinum	643
Bloomberg Law	849
LexisNexis	370
Total	32,284

Second, a subset of collaboration, co-development, development, and research transactions in the Biopharmaceutical Alliance Network were randomly identified and the formal contracts governing those deals were collected from either Bloomberg Law's or LexisNexis's EDGAR Filings databases. Most of the contracts sampled through this process involve publicly-traded biotechnology firms and pharmaceutical partners.[35] Public companies are required to disclose "material contracts" to the markets, and, while materiality is ultimately decided by the company, agreements amounting to 5% or more of the firm's revenues are usually disclosed. Commercially sensitive language in the agreements that are posted on the SEC's EDGAR database is often redacted, which limits full visibility.

Following de-duplication, and the elimination of "miss hits", the relevant details of those contracts were then hand-collected. Hand-collection involved agreements being coded double-blind and subject to a quality control process to ensure consistency. In total, data on 513 agreements were collected.

It is important to note that sampling agreements from the Recap, SDC Platinum, Bloomberg, and LexisNexis databases raises the possibility of selection bias. Successful firms that are able to go public may be overrepresented in

[35] As Lerner and Malmendier note, private company contracts are occasionally found in EDGAR, such as when biotechnology companies issue an initial public offering and, in turn, disclose prior material contracts that are still operative (Lerner and Malmendier 2010).

the sample—a form of "backward looking bias" affecting many financing and contracting studies (Lerner and Malmendier 2010). This might mean that exchange hazards may be less acute in the sampled agreements than in the broader population of alliances, since the characteristics of these publicly-traded firms, which are presumably more successful than an average company in the industry, may have been partially observable at the time of contracting, leading to more muted use of formal governance mechanisms. This creates reason for caution when generalizing from the study's results, although, as Lerner and Malmendier note, this form of selection bias only affects the strength of an estimated effect and not its directionality (Lerner and Malmendier 2010, pg. 225).

3.2.3 Variable Selection

Dependent Variables

As noted above, many alliance contracts are highly complex documents that include hundreds of provisions. At this early stage, however, the focus here is upon the use of a single dependent variable. **Governance Committee** is a binary variable, which is set to one if one or more consensus-based committees are established in a given agreement.

The study focuses upon that term for two reasons. First, consensus-based governance committees are of particular theoretical interest—for instance, they are a core component of Gilson et al.'s braiding theory of relational contracting, where the committee plays the role of a "contract referee" (Gilson, C. F. Sabel, and R. E. Scott 2009)—and they have therefore begun to attract growing academic interest (J. Reuer and Devarakonda 2015; M. C. Jennejohn 2008–2009; M. C. Jennejohn 2010–2011; M. Jennejohn 2016). Second, review of the practitioner literature (see Weisburd et al. 2010) and discussions with practitioners indicate that governance committees, in addition to the terms of the license grants and termination provisions, are some of the most important provisions negotiated in an alliance agreement.

Explanatory Variables

The hypotheses introduced above posit that relational and structural social capital correlate differently with the use of formal contract terms. To measure the effect of relational social capital, I delineate a binary variable, **Prior Deals**, which is set to one if the parties to the agreement had at least one prior deal before entering into the given agreement.[36] Note that any type of contractual arrangement in the Biopharmaceutical Alliance Network dataset—including, for instance, a license or a manufacturing agreement—counts as a prior deal for the delineation of this variable.

Explaining how the structural social capital variable is delineated requires some familiarity with some of the basic concepts of network analysis. The basic constituent parts of any network are the vertices or nodes, which here are the companies entering into contracts with one another, and the edges or links, which represent the contractual relationships between the firms. Once those nodes and links are identified, one can then identify the "ego network" or "neighborhood" for each node, which is the sub-network of nodes with which a given firm has direct links (Jackson 2010, pg. 28). With those networks assembled, we can then run some simple analytics to understand their structure. we can analyze the density of the links in a network, with network density measured as the actual number of connections between nodes in the network compared to the total possible number of connections (Jackson 2010, pg. 29). More advanced analytical tools are available, such as the centrality measures discussed below.

Figure 3 below depicts a graph of the Biopharmaceutical Alliance Network, and Table 2 summarizes basic descriptive statistics for the network. Over 8,400 companies participate in the network, with over 33,000 contractual relationships among them.

[36]The Prior Deals variable delineated here is similar to the "repeat ties" variable Robinson & Stuart use to measure "proximity" between alliance partners in a network (Robinson and Stuart 2007b). Robinson & Stuart use another measure of proximity, the number of ties to the same third parties that alliance partners share (id.), which was too computationally intensive to recreate here due to the size of the Biopharmaceutical Alliance Network.

Figure 3: Network Graph of Biopharmaceutical Alliance Network

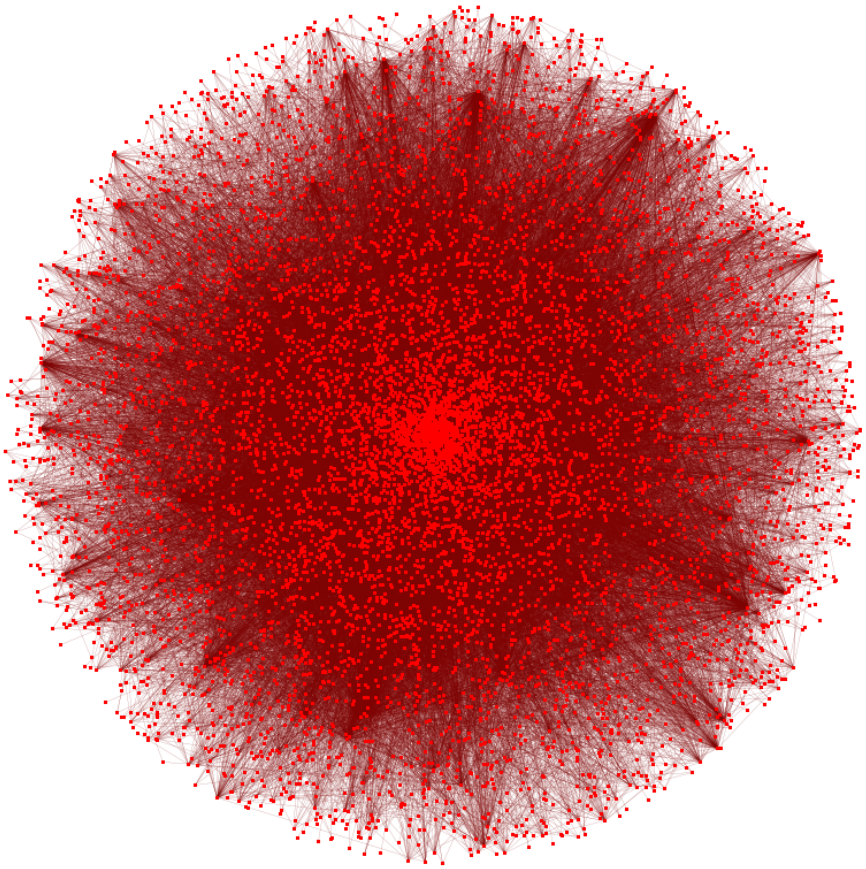


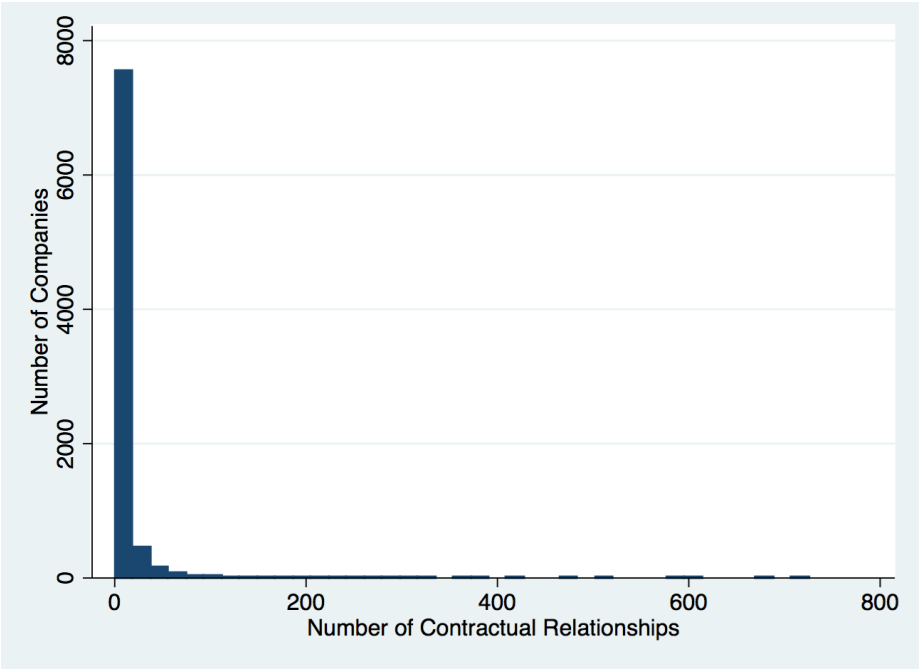
Table 2: Basic Descriptive Network-Level Measures for Pharmaceutical Alliance Network

Measure	**Value**
Nodes	8,415
Links	33,279
Density	0.00047
Network Reachable Diameter	17

At first glance, the sheer number of companies and contractual relationships in the industry suggests that information must move uniformly through the network. However, Figure 4 below indicates that the distribution of links among nodes in the Biopharmaceutical Alliance Network is not uniform. Some companies, such as Janssen and Pharmacyclics, are relatively deeply embedded in the network, but most market participants are loosely connected with other

companies. To measure the different levels of embeddedness for each company, this study follows Robinson & Stuart and uses the eigenvector centrality of each node (Robinson and Stuart 2007b). Each party's centrality was calculated based on the industry network as it was constituted for the previous three years prior to the data that a given agreement was executed. Eigenvector centrality is a spectral measure that calculates the centrality of a node in a network as a function of the centrality measures of the other nodes to which it is directly connected, and in that respect it captures the difference between being embedded in a thickly interconnected neighborhood and being embedded in a more peripheral one (Jackson 2010, pp. 40-43). That makes eigenvector centrality typically more accurate than simpler centrality metrics, such as total degree centrality, which is a simple sum of all of a node's links. The centrality measures of all parties to the agreement were then summed to create a continuous variable, **Eigenvector Centrality**, since the level of embeddedness of all parties affects the ease by which their information diffuses through the industry network.

Figure 4: Total Number of Contractual Relationships Between Companies in Pharmaceutical Alliance Network



That extremely right skewed distribution, where the majority of actors in the industry have relatively few alliances but a few companies are parties to many, suggests that the potency of informal governance varies depending upon one's position within the network.

Controlling for Diverse Exchange Hazards

There are, of course, other possible factors influencing parties' choices to include governance committees and convenience termination provisions in their contracts. Prior research argues that uncertainty plays a critical role in the design of alliance agreements by rendering research objectives and obligations non-contractible (Gilson, C. F. Sabel, and R. E. Scott 2009; Lerner and Malmendier 2010). Contractibility is measured here in two respects, First, the control variable **VIX**, which is the value of the VIX index on the day an agreement in the sample was executed, is used as a measure of aggregate environmental

uncertainty.[37] As a more specific method for measuring the contractibility of a deal, the study also delineates a binary variable, **Multistage**, which is set to one if there are two or more project stages (e.g., initial research, development, manufacturing, and/or commercialization). Presumably, outcomes are more difficult to foresee in multistage, as opposed to single stage, transactions. These measures improve upon prior approaches to measuring contractibility. For instance, previous work has measured contractibility by whether specific targets are identified in the recitals to the alliance agreements (Lerner and Malmendier 2010). However, some agreements are structured so that no specific targets are mentioned in the recitals but are rather listed in an exhibit, which is often redacted in the publicly available version of the agreement. Redactions rarely obscure whether a deal has multiple stages, however, which makes Multistage a more robust measure of contractibility. Furthermore, to the author's knowledge, no study has considered the effects of environmental uncertainty as measured through the VIX index or other similar variable.

A key part of the study is examining how different exchange hazards may affect the sampled agreements. To measure hold-up risk, the study delineates a categorical variable, **Asymmetric Background IP**, which is set to one if only the R&D partner grants an exclusive license to its background intellectual property, and set to zero if the parties make symmetrical exclusive license grants. The presumption is that the hold-up threat to the R&D partner is greater where asymmetrical license grants are made.[38] Measuring hold-up risk is often difficult because indicia of relationship-specific investment are often costly to observe.[39] The Asymmetric Background IP variable has the advantage of using the express terms of the license grants in the alliance contracts to determine the extent of asset specificity, and is therefore a highly accurate and low cost measure of as-

[37] More specifically, the VIX index is a measure of market expectations of near-term (30-day) volatility.

[38] Both parties granting exclusive licenses is similar to Williamson's notion that exchanging "hostages" is one solution to hold-up (Williamson 1985)

[39] Joskow's classic study of coal contracting arrangements hand-collected data on the extent to which suppliers' and buyers' sites were co-located, there is investment in specific capital equipment, and general investment in a supplier's productive capacity that would not have occurred absent the transaction (Joskow 1987).

set specificity. To measure spillover risk, I delineate a binary variable, **Joint Foreground IP**, which is set to one if the IP resulting from the collaboration is to be jointly owned by the parties. Under U.S. patent law, joint ownership allows either owner to exploit the technology without the consent of the other (Song & Enchelmayer 2015), which increases the possibility that one's counterparty undertakes a course of action against one's interests. Finally, I delineate a binary variable, **Task Interdependencies**, to measure entropy risk. That variable is set to zero if the parties' tasks are completely pooled (*i.e.*, the parties' activities are entirely separated from one another), and set to one if their tasks are more intertwined, such as sequentially ordered tasks. The assumption is that more intertwined task interdependencies present greater opportunities for project management problems.

Other Controls

Another possibility is that formal contract terms are standardized to some extent within the industry, which might affect parties' choice to include the dependent variable provisions in their agreements. To account for that possibility, a binary control variable, **Top 2 Law Firm**, is set to one if at least one of the parties to an agreement is represented by either WilmerHale LLP or Cooley LLP. Those two firms are singled out, because conversations with practitioners indicate that those two law firms are particularly active in representing companies negotiating alliance agreements.[40] Analysis of the notice provisions in the sampled contracts, which often disclose the external counsel involved on the transaction, confirmed that WilmerHale and Cooley were the most active outside law firms in the market. Given their prominence in the market, it is possible that WilmerHale and Cooley have standardized their terms to a significant extent, which is the effect the Top 2 Law Firm variable is meant to

[40]Note that, based on the data discussed below, Wilmer Hale and Cooley advised on deals accounting for 16% of the total number of connections between firms in the Biopharmaceutical Alliance Network. That figure is similar to a standard market share calculation, suggesting that the market for transaction advisory services in the Pharmaceutical Alliance Network is relatively un-concentrated.

capture.[41] Finally, year fixed effects regression models are estimated to control for the possibility that certain formal contract terms diffuse through the market over time.

It may be the case that formal contract terms, such as Governance Committees, respond to the quality of the R&D company participating in the collaboration. For instance, a company providing financing and clinical trial expertise may insist upon a committee or at will termination provision when it collaborates with a young or financially stressed R&D partner. Obtaining data on the R&D partners' financial health is difficult, because many of these firms are privately held. Ideally, a measure of financial distress would be used, but the information required for constructing such a measure is typically unavailable. As an alternative, the R&D partners' financial viability is roughly captured with the continuous variable **R&D Co EBITDA**, which is the R&D partner's EBITDA for the last fiscal year prior to the execution of a given alliance agreement. Annual EBITDA figures for R&D partners were collected from CapitalIQ, for public companies, and PrivCo, for private companies.

Another possibility is that formal contract terms respond to standardized policies within the companies financing the research. For instance, a large pharma attempting to rationalize the internal management of its alliance portfolio may have a default rule that all of its collaborations will have a certain number of governance committees.[42] In that sense, for instance, the governance committee structure is a response to infra-firm issues rather than concerns arising from the broader industry network. Hand-collecting data on such

[41] It is possible that external counsel serves as a reputational signal—*i.e.*, a firm may retain a preeminent law firm in order to signal its sophistication and quality to its counterparty, similar to the signaling role venture capital firms and investment banks can play (Hsu 2004; Fang 2005). Interestingly, Lerner and Malmendier, who use the reputation of the investment bank that brought an R&D company public as a proxy for firm quality, find no significant correlation between bank reputation and termination provision structure (Lerner and Malmendier 2010). Here, examination of the data reveals that WilmerHale and Cooley nearly always represent the party—usually the financial partner—with the greater structural social capital, which is not consistent with a small company leveraging an external law firm's reputation. It is possible, however, that the signaling value of repeat player law firms is greater for small biotech start-ups, whose deals are not regularly disclosed publicly and therefore excluded from the sample here.

[42] Note that, contrary to that assertion, conversations with practitioners indicate that the formal contract terms serving as dependent variables here are usually heavily negotiated.

company policies is prohibitively costly, and so a proxy is used here as an alternative. To approximate such potential internal causes for the adoption of certain formal contract terms, the continuous variable **Financing Company Revenues**, which measures the annual revenues of the financing company for the year prior to the execution of the contract, is delineated. Data for Financing Company Revenues were hand-collected from CapitalIQ, for public companies, and PrivCo, for private companies.

It is also possible that parties use alternative governance mechanisms other than the provisions delineated as dependent variables. For example, a pharmaceutical company's acquisition of an equity stake in the biotech research company may serve as a substitute for contractual governance mechanisms (see Oxley 1997). The binary variable **Equity Stake** is set to one if an alliance agreement or the securities filings discussing a given alliance agreement indicate that there is an acquisition of an equity stake.

Finally, another possibility is that differentials in bargaining power affect the parties choice to adopt the provisions that are the dependent variables in this study. A particularly specific measure of such differentials is the ratio of upfront consideration to milestone payments in the alliance contracts: Discussions with practitioners suggest that a larger proportion of milestone consideration indicates that the pharmaceutical company has greater bargaining power, while a larger proportion of upfront compensation indicates that the biotech research company enjoys relatively greater bargaining power. Thus, this study controls for differences in parties' bargaining power by measuring the proportion between up-front and contingent consideration, captured in the continuous variable **Consideration Ratio**.

3.2.4 Methodology

The dependent variable is binary, and therefore a logistic regression model is specified to test the correlations between that dependent variable and the explanatory variables outlined above. The baseline model estimates the log of the

probability that the dependent variable correlates with the various right hand side variables:

$$log\left(\frac{p}{(1-p)}\right) = \beta_0 + \beta_1 PriorDeals + \beta_2 EigenvectorCentrality + \beta_3 ControlVariables$$

where p indicates the probability of a dependent variable occurring, and β_i are the regression coefficients associated with each independent variable. In addition to estimating main effects, interactions between Eigenvector Centrality and a number of independent variables, including Joint Foreground IP, Task Interdependencies, Asymmetric Background IP, and Multistage are studied.

3.2.5 Results

The results support hypothesis *H1* in that they show that the parties' combined Eigenvector Centrality has a positive and significant effect on Governance Committee use. The results of the analysis of interaction effects find evidence to support *H2a*. That is, the results show that Governance Committees are more likely to occur in deals where both Eigenvector Centrality is higher and where Joint Foreground IP is provided for. Interestingly, interactions between Eigenvector Centrality and Asymmetric Background IP, a measure of asset specificity, do not have statistically significant correlations with Governance Committee use, suggesting that hold-up problems do not drive the use of the committees. Furthermore, analysis of interaction effects between Prior Deals and Joint Foreground IP, Task Interdependencies, Asymmetric Background IP, and Multistage was also undertaken, and none of the interactions had a statistically significant relationship with governance committee incidence. Taken together, those results provide, on balance, preliminary support for the disruption thesis.

Characteristics of the Sample

Before examining correlations, descriptive statistics are reported to orient the reader to the data. As reported in Table 3, the dependent variables studied here occur with considerable frequency in the sampled agreements. Nearly three-fourths of the agreements have at least one governance committee established. For additional context, Table 3 also reports that a little over one-third have a multi-tier committee system.

Table 3: Descriptive Statistics of Dependent Variables

Variable	**Value**	**Percentage**	**Obs.**
1+ Governance Committees	406	74.50	545
Alliances with two or more committees	212	38.90	545

Both relational and structural social capital are unevenly distributed within the sample. Table 4 reports, and Figure 5 depicts, the number of alliances in the sample where the parties had a prior deal. Approximately 22% of the alliances had at least one prior deal, although, interestingly, only 3.66% had two or more prior deals.[43]

Table 4: Descriptive Statistics of Prior Deals between Alliance Partners

Variable	**Value**	**Percentage**	**Obs.**
Alliances with no prior deals	422	77.29	546
Alliances with at least one prior deal	124	22.71	546

Table 5 reports, and Figure 6 depicts, descriptive statistics of the parties' structural social capital. Parties' eigenvector centralities are right skewed, with a relatively large number of market participants having low centrality measures.[44] Because eigenvector centrality statistics are not immediately intuitive to many readers, statistics on the parties' total degree centralities are also provided. A node's total degree centrality is simply a count of all of the links that node has with other nodes. The distribution of total degree centrality measures is also right skewed, with a large number of parties having low degree centrality and a small number having many connections to other companies in the

[43] Baker, Gibbons & Murphy find a similarly low rate in their study of pharmaceutical collaborations. (Baker et al. 2008)

[44] A log transformation was used to normalize the distribution of Eigenvector Centrality when the models were estimated.

network.[45] The alliance with the greatest total degree centrality involved two parties with 2,630 distinct contractual relationships with other companies in the Biopharmaceutical Alliance Network.

Table 5: Descriptive Statistics of Alliance Partners' Network Centrality Measures

Variable	**Mean**	**Std.Dev**	**Min**	**Max**	**Obs.**
Combined total degree centrality	231.61	255.82	2	2630	546
Combined eigenvector centrality	0.0284	0.047	0.00000532	0.6949	546

Figure 5: Distribution of Prior Deals between Alliance Partners

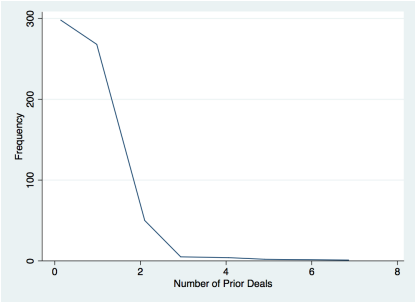
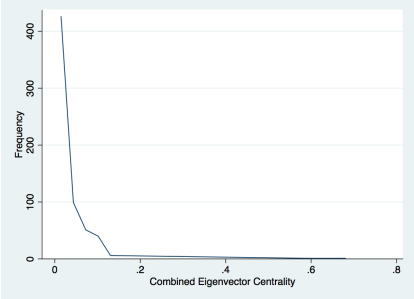


Figure 6: Distribution of Alliance Partners' Combined Eigenvector Centrality Measures



Finally, Table 6 below reports descriptive statistics for most of the control variables. Over 70% of the agreements in the sample involved multistage collaboration. Deals pooled tasks in one entity approximately 38% of the time, and intertwined them between the parties about 62% of the time. Approximately 35% of the deals involved the R&D partner licensing background intellectual property on an exclusive basis. Over 60% of the transactions provided for joint ownership of foreground intellectual property. With respect to possible standardization, Cooley and WilmerHale are the most active law firms in the sample, advising clients in over 16% of all contracts in the sample.

[45] Graphs of the distribution of total degree centralities of the companies in the Biopharmaceutical Alliance Network are not reported here.

Table 6: Descriptive Statistics of Binary Control Variables

Variable	**No.**	**Percentage**	**Obs.**
Deals with 2+ stages	401	73.44	546
Task Interdependencies			
Pooled	208	38.10	546
Sequential	338	61.90	546
Asymmetric Background IP	189	34.62	546
Deals where foreground IP is jointly owned	331	60.85	544
Deals where an equity stake is acquired	129	41.48	311
Top 2 Law Firm	89	16.30	546

Analysis of Main Effects Show that Relational and Structural Social Capital Affect Governance Committee Use Differently

The analysis begins by testing *H1*, which posits that Governance Committees correlate positively and significantly with Eigenvector Centrality, and do not correlate positively and significantly with Prior Deals. Table 7 below report simple univariate comparisons between Governance Committee and the explanatory variables of interest. The second column in each table reports the mean for each independent variable for the agreements including a Governance Committee, and the third column reports the mean for each independent variable for the agreements not including a Governance Committee. Means of the log transformations of Eigenvector Centrality are reported in both tables.

Table 7: Univariate Comparisons of Means of Governance Committee and Explanatory Variables

	Governance Committee		Test of Difference	
Variable	**Yes**	**No**	***t*-statistic**	***p*-value**
Prior Deals	0.25	0.17	2.03	0.04
Eigenvector Centrality	-4.30	-5.11	4.91	0.00

The t-statistics and p-values reported in Table 7 indicate that both Prior Deals and Eigenvector Centrality are significantly correlated with Governance Committee, and that Eigenvector Centrality is significantly correlated with Convenience Termination use. Taken alone, those results are inconclusive with respect to *H1*. However, the results of the following regression models tell a different story.

Table 8 below reports the results of the logistic regression models specified to study the use of Governance Committees. Model 1 includes only the basic control variables related to exchange hazards, and Model 2 then includes the explanatory variables Prior Deal and Eigenvector Centrality and the additional control variable Top 2 Law Firm. Both Model 1 and Model 2 control for year fixed effects. The results provide initial support for hypothesis *H1*. As *H1* hypothesizes, use of a Governance Committee is positively correlated with the parties' Eigenvector Centrality, and that relationship is significant at the 1% level. The relationship between Governance Committee and Prior Deals is positive, but the relationship is not statistically significant. In short, as Eigenvector Centrality increases, the odds of including a Governance Committee in a contract also grow.

It is possible, however, that those results are biased due to omitted variables. For instance, perhaps the terms of the agreements are affected by a disparity in bargaining power, the acquisition of an equity stake in the R&D partner by the financing partner, the internal complexity of the financing partner, or increased performance risk on the part of the R&D partner. To control for those possibilities, Model 3 adds the variables Consideration Ratio, Equity Stake, Financing Co Revenues, and R&D Co EBITDA. A material amount of data was missing in a number of observations for those control variables. In order to avoid deleting cases, which erodes the analyses' statistical power, multiple imputation is used to impute missing Consideration Ratio data for for 373 alliances, missing Equity Stake data for 251 deals, missing Financing Co Revenues for 181 alliances, and R&D Co EBITDA data for 203 transactions. Multiple imputation is a simulation method that uses regression analysis to impute missing values (Rubin 2004), and is often less biased than more rudimentary methods such as mean imputation (where one imputes missing values based upon the average value in the available data) (Gelman and Hill 2016). A key assumption for the appropriate use of a multiple imputation model is that data is missing at random (Rubin 2004; Dong and Peng 2013), an assumption that is met here, because

few parties repeat in the dataset. Where the randomness assumption is met, and where a relatively large number of simulations are combined, studies have found that a large amount of missing data, such as 50% or greater, can be imputed without introducing bias into the results (Lee and Jr 2011). There is no precise threshold on the number of iterations to run, although research suggests that, in situations where a large amount of data is missing, running less than ten iterations may be problematic (Dong and Peng 2013). Here, to reduce the possibility of bias in the imputed data, all variables in the explanatory models were included in the multiple imputation models, and forty iterations were run for each model.[46]

The results of Model 3 are consistent with Models 1 and 2. Once again, use of a Governance Committee is positively correlated with the parties' Eigenvector Centrality, and that relationship is significant at the 1% level. The relationship between Governance Committee and Prior Deals is positive, but again the relationship is not statistically significant. It is also worth noting that positive and statistically significant relationships between the use of Governance Committees and a number of the control variables are identified. Multistage agreements are more likely to include a Governance Committee, suggesting that Governance Committees are used to address contractability problems. Sequential Task Interdependencies and Joint Foreground IP are also both positively and significantly correlated with Governance Committee use, suggesting that spillover and entropy issues also motivate the use of Governance Committees. Notably, the measure for potential hold-up threats—the licensing of background intellectual property on an exclusive basis—is not significantly correlated with the use of a Governance Committee. Table 8 also reports positive and statistically significant correlations between Governance Committees and Top 2 Law Firms. Deals with either Cooley or WilmerHale involved were more likely to include a Governance Committee, suggesting that there may be an element of standard-

[46]Multiple imputation models were estimated using Stata's MI suite. Functionally identical results were achieved using the ICE package in Stata as an alternative toolkit for undertaking multiple imputation.

ization at the law firms counseling on these deals. Neither Consideration Ratio nor Equity Stake are significantly correlated with Governance Committee. Both Financing Co Revenues and R&D Co EBITDA are significantly correlated, and the directions of the relationships are what we might expect—larger Financing Co Revenues correlates positively with Governance Committee incidence, while the likelihood of including a Governance Committee in an alliance contract decreases as as R&D Co EBITDA increases. Those results suggest that there may an element of standardization in governance committee design at large companies, and that governance committee use responds in part to the quality of the R&D partner; however, note that the coefficients of both Financing Co Revenues and R&D Co EBITDA on Governance Committee use are exceedingly small.

Table 8: Results of Logistic Regression Analysis for Main Effects of Social Capital Measures on Governance Committee Incidence

	(1)	(2)	(3)
Governance Committee			
VIX	0.0412	0.0264	-0.124
	(0.12)	(0.07)	(-0.38)
Multistage	0.844**	0.806*	0.750*
	(2.77)	(2.51)	(2.36)
Task Interdependencies	0.752**	0.851**	0.590
	(2.63)	(2.87)	(1.89)
Asym Background IP	-0.199	-0.144	-0.308
	(-0.79)	(-0.55)	(-1.13)
Joint Foreground IP	1.155***	0.959***	1.150***
	(4.72)	(3.79)	(4.36)
Top 2 Law Firm		1.027*	1.099*
		(2.21)	(2.32)
Prior Deals		0.471	0.418
		(1.55)	(1.31)
Eigenvector Centrality		0.261***	0.320***
		(3.87)	(4.37)
Consideration Ratio			-0.246
			(-1.24)
Equity Stake			0.368
			(0.99)
Financing Co Revenues			0.00000200*
			(2.03)
R&D Co EBITDA			-0.000611*
			(-2.23)
Constant			1.389
			(1.28)
Observations	511	511	512
Pseudo R^2	0.146	0.198	.

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

One question arising from the results above is whether they are sensitive to how the parties' network centralities are being combined. To explore this issue,

the Eigenvector Centrality variable was unpacked by breaking out the individual parties' respective eigenvector centralities, **R&D Co Centrality** and **Financing Co Centrality**, and then the relationship of those isolated centrality measures and governance committee use was analyzed.[47] Table 9 below reports the results of the logistic regression models estimating the relationship between the centrality measures and governance committee incidence. Both R&D Co Centrality and Financing Co Centrality are positively and significantly correlated with governance committee use. That is consistent with the disruption thesis in the sense that governance committees, which are a tool for both parties to stop spillovers, are responding to heightened spillover risk from both the R&D partner and the financing partner.

[47] To construct the R&D Co Centrality and Financing Co Centrality variables, the sampled contracts were analyzed to determine which company was the R&D partner and which was the financing partner. Due to ambiguities in the publicly available versions of the agreements, categorization of the parties was possible in 290 alliances in the sample, reflecting a conservative approach. Eigenvector centrality measures in the Biopharmaceuticals Alliance Network were then calculated for the R&D partners and financing partners in those 290 deals.

Table 9: Results of Logistic Regression Analysis for Main Effects of R&D Partner Centrality and Financing Partner Centrality on Governance Committee Incidence

	(1)	(2)	(3)	(4)
Governance Committee				
VIX	-0.242	-0.234	0.226	0.128
	(-0.45)	(-0.45)	(0.44)	(0.25)
Multistage	1.132*	0.956	0.728	0.795
	(2.29)	(1.93)	(1.54)	(1.68)
Task Interdependencies	1.135**	1.039*	1.084*	1.024*
	(2.58)	(2.43)	(2.55)	(2.47)
Asym Background IP	0.0907	0.190	-0.123	-0.116
	(0.23)	(0.51)	(-0.29)	(-0.29)
Joint Foreground IP	1.158**	1.125**	1.708***	1.603***
	(3.22)	(3.20)	(4.56)	(4.37)
Top 2 Law Firm	0.695	0.616	0.794	0.744
	(1.06)	(0.92)	(1.11)	(1.06)
Prior Deals	0.424	0.303	0.180	0.151
	(0.86)	(0.63)	(0.35)	(0.30)
Biotech Eigenvector Centrality	0.236**		0.230*	
	(2.67)		(2.41)	
Financing Eigenvector Centrality		0.156*		0.164*
		(2.08)		(2.13)
Consideration Ratio			0.0321	0.0257
			(0.10)	(0.08)
Equity Stake			-0.134	-0.199
			(-0.28)	(-0.43)
Financing Co Revenues			0.00000339	0.00000297
			(1.50)	(1.39)
R&D Co EBITDA			-0.000785	-0.000663
			(-0.90)	(-0.77)
Constant			-0.0340	-0.202
			(-0.02)	(-0.12)
Observations	281	281	290	290
Pseudo R^2	0.254	0.220	.	.

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Analysis of Interaction Effects Shows that Greater Network Centrality Exacerbates Spillover Problems

We now turn to analysis of certain interaction effects in order to discern whether greater network embeddedness interacts differently with various exchange hazards. Recall that hypothesis *H2* posits that Governance Committees are used more often in deals where Eigenvector Centrality interacts with the incidence of Joint Foreground IP, Task Interdependencies, Multistage, or Asymmetric Background IP.

As reported in Table 10, tests of interaction effects found evidence supporting *H2a* in that the combination of higher Eigenvector Centrality and Joint Foreground IP corresponds positively and significantly with Governance Committee. There is no evidence found supporting *H2b*, *H2c*, or *H2d*: The interactions between Eigenvector Centrality and Task Interdependencies, Asymmetric Background IP, and Multistage do not significantly affect Governance Committee incidence. Taken together, the evidence on interaction effects suggests that Governance Committees are responses to spillover problems, and that entropy, hold-up and contractibility concerns have little bearing on Governance Committee incidence.

Table 10: Results of Logistic Regression Analysis for Interaction Effects of Social Capital Measures on Governance Committee Incidence

	(1)	(2)	(3)	(4)
Governance Committee				
Task Inter × Centrality	0.219			
	(1.55)			
Joint Foreground IP × Centrality		0.322*		
		(2.27)		
Multistage × Centrality			0.163	
			(1.09)	
Asym Background IP × Centrality				-0.0520
				(-0.37)
Exchange Hazard Controls	Y	Y	Y	Y
Other Controls	Y	Y	Y	Y
Year Fixed Effects	N	N	N	N
Constant	0.718	0.669	0.912	1.505
	(0.62)	(0.59)	(0.78)	(1.33)
Observations	512	512	512	512
Pseudo R^2	.	.	.	.

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The effects of interactions between Prior Deals and the four types of exchange hazards were also analyzed. The results of those analyses, unreported here, found no statistically significant relationships between Governance Committee use and the interactions of Prior Deals with Joint Foreground IP, Task Interdependencies, Multistage, or Asymmetric Background IP. It appears that network centrality exacerbates spillover concerns, but repeated deals between the parties has no such effect.

In summary, the results of the regression analyses reported above support hypotheses *H1* in that they show the dependent variable Governance Committee correlating positively and significantly with Eigenvector Centrality. Notably, no evidence of a significant correlation between the dependent variable and Prior Deals is found. Examination of interaction effects between Eigenvector

Centrality and Joint Foreground IP produces similar results, confirming *H2a*. On balance, the results provide preliminary support for the disruption thesis.

An additional question is whether the results above are sensitive to the way the dependent variable, Governance Committee, is being measured. Do the relationships identified above hold when a more detailed measure of committee structure is used? To explore that possibility, the analyses above were run on a new dependent variable, **Multiple Committees**, which is an ordinal variable that increases in value based upon the total number of committees, including sub-committees, established in an alliance agreement. For instance, the Multiple Committees value for the Janssen/Pharmacyclics Alliance discussed above is six because the contract creates six committees, as depicted in Figure 2. Ordinal logit models were specified to study the relationship between Multiple Committees and the right-hand side variables introduced above.

As reported in Table 11 below, the results for Multiple Committees are highly similar to the results for Governance Committees reported above. Analysis of main effects reveals that Eigenvector Centrality is positively and significantly correlated with parties' choice to introduce more than one committee into their alliance relationship. Prior Deals is once again not significantly related to the use of Multiple Committees.

Table 11: Results of Logistic Regression Analysis for Main Effects of Social Capital Measures on Multiple Governance Committee Incidence

	(1)	(2)	(3)
Multiple Committees			
VIX	-0.0346	-0.00540	-0.0671
	(-0.16)	(-0.02)	(-0.30)
Multistage	0.938***	0.940***	1.001***
	(4.08)	(4.00)	(4.06)
Task Interdependencies	0.708***	0.766***	0.613**
	(3.54)	(3.79)	(2.80)
Asym Background IP	-0.399*	-0.370*	-0.497**
	(-2.30)	(-2.11)	(-2.67)
Joint Foreground IP	1.210***	1.024***	0.977***
	(6.40)	(5.31)	(4.83)
Top 2 Law Firm		0.528*	0.560*
		(2.42)	(2.41)
Prior Deals		0.108	0.132
		(0.56)	(0.64)
Eigenvector Centrality		0.242***	0.281***
		(4.70)	(5.14)
Consideration Ratio			-0.183
			(-1.21)
Equity Stake			0.370
			(1.52)
Financing Co Revenues			0.000000572
			(1.32)
R&D Co EBITDA			-0.000497**
			(-2.68)
Observations	513	513	513
Pseudo R^2	0.087	0.106	.

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

As Table 12 reports, analysis of interaction effects produces highly similar results also. The interaction of Joint Foreground IP and Eigenvector Centrality is positively and significantly correlated with parties' choice to use multiple

governance committees, suggesting that spillover concerns drive the use of these formal contract provisions. The interactions of the other exchange hazard variables and Eigenvector Centrality are not significantly correlated with the dependent variable. The interactions between Prior Deals and the four exchange hazard variables were also analyzed. The results of those analyses, unreported here, found no significant relationships between the interactions and the use of Multiple Committees.

Table 12: Results of Logistic Regression Analysis for Interaction Effects of Social Capital Measures on Multiple Governance Committee Incidence

	(1)	(2)	(3)	(4)
Multiple Committees				
Task Inter × Centrality	0.203			
	(1.90)			
Joint Fore IP × Centrality		0.208*		
		(2.01)		
Multistage × Centrality			0.0775	
			(0.65)	
Asym Back IP × Centrality				-0.102
				(-0.96)
Exchange Hazard Controls	Y	Y	Y	Y
Other Controls	Y	Y	Y	Y
Year Fixed Effects	N	N	N	N
Constant	7.916***	7.829***	7.476***	7.052***
	(6.04)	(6.04)	(5.66)	(5.56)
Observations	513	513	513	513
Pseudo R^2	.	.	.	.

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

These results suggest that parties introduce multiple committees in order to structure information flows and introduce additional veto points as spillover risk increase as network centrality grows.

3.3 Summary

The results presented approve provide preliminary support for a theory of relational contracting that charts a course between the substitutionary and complementarity theories that currently dominate the field. The disruption thesis rejects substitutionary theory's oversimplified view that formal agreements are by nature inimical to informal governance. The evidence, identified elsewhere and confirmed once again in this article, that parties regularly choose to use extensive formal agreements in situations of high social capital is too clear to ignore. At the same time, the disruption thesis repurposes substitutionary theory's primary insight—that formal contracting can undermine the enforcement of informal social norms—by arguing that such interference can in fact be an *intention* behind a formal agreement.

The disruption thesis is quite similar in spirit to current complementarity theories, such as Gilson et al.'s braiding and Hadfield & Bozovic's scaffolding theses. They share a fundamental insight that formal agreements can be used to compensate for the limits of informal governance. However, the limits of relational contracts and the formal solutions to them are conceptualized quite differently. In Gilson et al.'s view, formal agreements are used in markets with high uncertainty and low social capital to foster the information flows necessary for parties to observe one another's performances and commitment, thereby artificially manufacturing the conditions required for informal governance to work (Gilson, C. F. Sabel, and R. E. Scott 2010). In Hadfield & Bozovic's view, formal agreements are used when social norms are uncertain to delineate clearly what behavior constitutes breach of the agreement, which is then enforced informally (Hadfield and Bozovic 2016). In both cases, the problem is that social capital is too diffuse for relational contracting to operate reliably. Here, the problem is quite different—parties can struggle not with a lack of social connections but with a surfeit. That shifts the role of a formal contract from necessarily fostering informal governance, in the sense of increasing connections and information flows, to undercutting those connections and flows. Formal agreements save

informal governance from itself.

Relatedly, the disruption thesis enjoys a parsimony that has been elusive in recent research advancing complementarity theories of relational contracting. Both the braiding and the scaffolding theses turn in significant part upon a categorical distinction between "observable" information—*i.e.*, performance information to which the parties to the agreement have access—and performance information that is "verifiable" by a third party tribunal. This distinction quickly grows complicated in practice. For instance, Gilson et al. argue that parties deliberately design only a subset of the provisions in an alliance contract to be verifiable, while the other terms are meant only to be observable (Gilson, C. F. Sabel, and R. E. Scott 2010; Gilson, C. F. Sabel, and R. E. Scott 2013). In that sense, braiding theory turns upon parties' and courts' ability to carefully parse observable and verifiable performance obligations. However, it is not entirely clear on the face of such agreement where those divisions between observable and verifiable obligations lie—alliance agreements often include hundreds of provisions, which an enforcement tribunal is required to enforce in their entirety under doctrines of interpretive consistency,[48] The disruption thesis side-steps such complications by simply asserting that terms in the formal alliance contract are what they are—obligations enforceable in court—and policy does not turn upon categorizing observable and verifiable terms.

There are, of course, limits to this study, which subsequent research will explore in more detail and which caution against drawing hasty conclusions. Most obviously, this study is limited to the biopharmaceutical sector, and it is not clear that the lessons drawn here are generalizable to other domains. Furthermore, this study only scratches the surface of the complex governance systems deployed to govern technology alliances. Scores of additional contract terms are used and must eventually be included in the analysis.

There are also limits with respect to the study's network analysis. First, the centrality measures used here are drawn from static, rather than dynamic

[48] See 11 Williston on Contracts s. 32:5 (4th ed.).

networks. Controlling for year fixed effects addresses the concern that patterns in governance committee and convenience termination can be explained as the evolution of "market" terms. But more subtle questions, such as whether a material shift in a company's network position over time affects contract design, have yet to be studied. It is also important to note that this study does not apply concepts of network brokerage. An influential line of scholarship originating in Burt's work (Burt 2009) argues that centrality measures do not capture situations where a node within a network connects, or brokers, two or more otherwise disconnected components within a network, which provides the node with unique access to information. Relatedly, the study does not analyze differentials between the alliance partners' network positions, which may also affect their governance strategies.

4 Contingent Market Infrastructure

While the disruption thesis reflects elements of substitutionary and complementarity theory to some extent, it marks a significant departure from the common foundation upon which both of those theories rely. In a fundamental respect, the view of the relationship between formal and informal contracts that emerges from the analysis above differs from the conventional wisdom regarding legal institutions' role in the economy. It is often said that businesspeople crave certainty, and in many respects that perspective informs traditional notions of market infrastructure. From that perspective, legal rules governing markets are optimal to the extent they are predictable (Douglass C North 1990; Douglass C. North 2005).[49] That predictability allows parties to order their affairs into the future, smoothing the way for investment.[50] Most commentary in this vein is

[49]Milhaupt & Pistor provide an excellent discussion of the conventional view (Milhaupt and Pistor 2008, pp. 17-25).

[50]This view can be traced back to Adam Smith, if not earlier, "Commerce and manufacturers can seldom flourish long in any state which does not enjoy a regular administration of justice, in which the people do not feel themselves secure in the possession of their property, in which the faith of contracts is not supported by law, and in which the authority of the state is not supposed to be regularly employed in enforcing the payment of debts from all those who are able to pay" (A. Smith 1976, pg. 910).

not so naive that it denies the need for flexibility—Simon's insight has not been forgotten (H. A. Simon 1951)—but the scale of that need is often implicitly quite circumscribed. In most accounts, social capital provides some "fudge" by which parties can deviate temporarily from performance obligations otherwise set in stone, allowing the contract terms to bend so that they do not break (see, e.g., Goetz and R. E. Scott 1981). From this perspective, all institutions, including flexibility-promoting social capital, ultimately promote the ideal of stability.

The view of institutional infrastructure presented here is quite different. Whereas conventional wisdom preaches certainty, the disruption thesis outlined here suggests that the pursuit of stable infrastructure is a false hope, if not counterproductive.[51] The interface between formal and informal infrastructure is deeply contingent, rooted in fundamental tensions between the multiple exchange hazards parties must confront. As a result, parties engage in arbitrage by shifting between what appear on the surface to be redundant institutions, but in reality are carefully calibrated responses to the various trade-offs collaborating parties must navigate. Institutions exist as options, rather than as permanent fixtures.

Dynamism is at the heart of this contingent view of market infrastructure. Baked into the perspective is the assumption that an institutional combination that works today will be inappropriate for a deal tomorrow, and thus institutions will need to be disassembled and recombined over time. The dynamism inherent in the concept of contingent market structure is new to contract economics, but it draws from a long lineage in the study of economic behavior, finding roots in Nelson & Winter's theory that economic change approximates principles of natural selection as organizational capabilities are refined through deliberate problem solving (Nelson and Winter 2009), Simon and the Carnegie School's efforts to theorize organizational decision-making and change (H. A. Simon 1976; March 1959), Schumpeter's work on creative destruction's role in achieving change in capitalist systems (Schumpeter 2013), Polanyi's theory of

[51] Devins et al. make a similar argument in the context of public law (Devins et al. 2015).

the "double movement" in capitalist systems (Polanyi 2001), and, ultimately, Marx's assessment of capitalism's inability to continue reproducing the institutional framework by which it is maintained (Marx 1926; Marx 1892). To study contingent market infrastructure is not to be entirely out to sea.

A broad literature has grown in recent years as a diverse collection of social scientists have built upon that foundation. Much of this new scholarship is directed toward understanding *organizations'* role in innovation processes, and in that respect it may appear inapplicable to the contracting behavior examined here. However, research on organizational evolution is closer to this study than we may think, if we take to heart Sabel's argument that the de-verticalization trends of the past generation have shifted a substantial amount of economic activity from *within* to *across* firm boundaries (C. F. Sabel 1993; C. F. Sabel 1994; Charles Sabel and Zeitlin 2004). The alliances examined here reflect that shift by incorporating some of the hierarchical decision controls and termination abilities that are traditionally associated with managerial fiat.[52] What was once organizational is now contractual.

The interdisciplinary literature on endogenous innovation in both organizations and markets provides three important insights that provide a framework for articulating a theory of contingent market infrastructure. The first teaching is that we must shift our frame of reference, because the traditional measures provided by transaction cost economics for assessing the efficiency of institutional arrangements are incomplete guides. A massive intellectual edifice has been constructed on the foundation of the transaction cost concept, which underpins the collection of fields that fall under the umbrella of the new institutional economics (Douglass C. North 2005; Williamson 1985). Institutional arrangements are understood as tools for reducing transaction costs, which directs normative energy toward identifying those institutions that will result in the greatest efficiencies. However, as Stark has argued, transaction costs are only half of the story: where institutional change is assumed, then "transfor-

[52]Bernstein underscores this point in her recent study of midwestern supply relationships (Bernstein 2015).

mation costs"—*i.e.*, the costs of restructuring economic institutions—are also acute (Stark 1996a). Whereas transaction costs are focused on static efficiency, transformation costs highlight the problem of achieving dynamic efficiency over time. Stark notes that this creates a trade-off: institutions that minimize short-term transaction costs may exacerbate long-term transformation costs (Stark 1996a), which is incidentally precisely the trade-off exemplified in the benefits and costs of using standardized contract terms (M. Gulati and R. E. Scott 2012). On the other hand, institutional "friction," which may be inefficient in the short term, may beneficially unsettle institutions over time so as to reduce long-term transformation (Stark 1996a, pg. 4). The intertemporality of the trade-off between transaction and transformation costs requires the ability to discount future transformation costs (and benefits) to present value, so that they can be accurately balanced with near-term transaction costs (and benefits). Actors' ability to undertake such discounting is an open question, and a number of scholars have noted that a pragmatic notion of rationality is needed to capture decision-making in such contexts (C. F. Sabel 1993; Dorf and C. F. Sabel 1998; Whitford 2002).

Recognizing the importance of transformation costs raises the issue of how they can be managed. Or, in other words, if endogenous change is an imperative, then how is it rationalized? This brings us to our second and third lessons, which both respond to that question.

The second teaching is that institutional structure—how the constituent parts of institutions are organized—can raise or lower transformation costs. Structure plays a particularly important role where institutions are complex, as is often the case in the modern economy. For instance, modular design of institutional systems may reduce the costs of recombination (Baldwin and Clark 2000; Helfat and Eisenhardt 2004). A modular system is one where its various sub-systems are isolated from one another, so that information is "hidden" within the boundaries of each module (Baldwin & Clark 2000). That isolation, of course, raises the question of how the different modules are to interoperate,

and so modular systems often use a common interface as the architecture holding the modules together (Baldwin & Clark 2000). So long as each module complies with the interface rules, their output will be compatible. That design reduces transformation costs in two respects: first, it allows infra-modular change to proceed without disturbing other parts of the system; and second, it allows modules to be plugged in and out of the system as needed (Baldwin & Clark 2000). The downside of this approach, however, is that the standard interface often requires significant upfront investment to define, and then there are significant incentives not to change that standard (Charles Sabel and Zeitlin 2004).

Modular design is not the only strategy for using system structure to reduce transformation costs. Institutional engineers can maintain high levels of integration within a complex system. That of course raises the costs of change—deep connections between sub-systems mean that adjusting one sub-system will require follow-on tinkering with the rest of the system. Those transformation costs can be reduced, however, through routines of information sharing, which Piore & Sabel originally referred to as "flexible specialization" (Piore and Charles Sabel 1984). In short, disciplines of error detection and cooperative learning within the personnel responsible for designing and maintaining the complex system reduce transformation costs (C. F. Sabel 1994). Those transformation costs may never be fully reduced to the level achieved in a modular system, but flexible specialization may be advantageous in that it requires relatively low upfront investment and is less susceptible to lock-in.

The third teaching, related to the second, is that organizations can develop capabilities for change. In the last two decades, there has been an explosion of research exploring companies' "dynamic capabilities" (Teece, Pisano, and Shuen 1997) and scholars have developed a "resource-based view" of the firm as an alternative to the efficiency-based model of Williamsonian transaction cost economics (Williamson 1985) in part to accommodate internal sources of change (Barney 1991). A lesson of the research on dynamic capabilities is that success-

ful organizational change often requires maintaining a strategic tension within a company. The tension arises from the need to execute existing strategy while at the same time refashioning that strategy in response to new market developments. Company's with robust dynamic capabilities manage (but do not eliminate) that tension by, first, creating disciplines for interrogating existing strategy, formulating new strategy, and reconfiguring assets accordingly (Teece, Pisano, and Shuen 1997). Although those disciplines are mutable (Eisenhardt and Martin 2000), they are often routinized to some extent, since the imperative to adjust does not subside (Teece 2014). Second, companies with dynamic capabilities often loosely couple organizational assets, so as to reduce the costs of recombination (Helfat and Eisenhardt 2004; Teece 2007). Taken together, those two steps mean that companies with high dynamic capabilities purposefully build a significant measure of instability into their organizations, which (ideally) occupy a "goldilocks" range between the stagnation of overly-centralized control and the disorder of excessive decentralization.[53]

Applied to contract theory, the scholarship discussed above invites us to shift attention away from focusing solely upon party characteristics, risk preferences, and environmental uncertainty as the determinants of how agreements are designed, and to think of contract design as an innovation process in itself. Recent work has taken an important step in that regard as it has explored how new contractual systems are designed, either through a modular structure (Triantis 2012–2013; Hwang 2015–2016; M. Jennejohn 2016) or in a more

[53]Helfat & Eisenhardt provide an example of how dynamic capabilities are built within an organization in their study of a Fortune 100 technology company's organizational restructuring (Helfat and Eisenhardt 2004). The company had a decentralized organizational structure, with multiple divisions serving related but distinct markets. The company experienced frequent shifts in customer needs and introductions of disruptive technologies, which placed stress on the organizational boundaries between divisions. Rather than overhauling the entire company's divisional structure in response to every market development, the company developed a unique institutional response: a system of "charters," which defined an area of product-market responsibility, such as "desktop computing," which could be reassigned from division to division without transferring personnel or capital assets. As new markets were created, new charters were designed in turn; however, interestingly, the company did not also create a new separate division, with its own personnel and capital assets. Rather, company executives assigned the new charter to a division that was experiencing modest growth due to the maturation of its original market. Relatedly, when new business ideas were developed internally within a division, the company's senior executives would design a new charter around the idea but then assign it to a business unit other than the one where the idea originated.

integrated architecture (M. Jennejohn 2017; Hwang and M. Jennejohn 2017). The challenge is to continue advancing these preliminary studies and to begin consolidating lessons into a panoramic view of modern market infrastructure. This article makes an important contribution to this young literature by providing "micro-foundations" that can explain what drives the recombination of institutions—namely, this study provides us with a sense of the complicated trade-offs among exchange hazards parties must navigate, how shifts among those trade-offs might produce friction over time, and, in turn, how change might unfold from deal to deal.

5 Conclusion

This paper has outlined the beginnings of a new theory of relational contracting. Whereas prior scholarship has emphasized the role of social capital in policing opportunism problems, this article shifts focus to also include social capital's costs. Being embedded in an industry network may speed the transmission of reputational information, but it also complicates parties' ability to appropriate the rents from their assets. Certain provisions in formal contracts may be designed to address those costs, and those terms in turn present a trade-off: the very mechanisms that control spillover problems may interfere with reputational constraints. Qualitative and quantitative analyses provide preliminary evidence that greater network embeddedness correlates with increased use of certain disruptive formal contract terms.

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