Braided Agreements and New Frontiers for Relational Contract Theory

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I. INTRODUCTION

The corporate form is often viewed as one of the critical legal tools necessary to achieve the scale economies pursued across a number of markets during the Industrial Revolution.[1] Mass production required the raising of dramatic amounts of capital, which the corporation facilitated through unique characteristics, such as delegated management, perpetual existence, readily alienable shares, and limited stockholder liability.[2] By

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1. *See* NATHAN ROSENBERG & L. E. BIRDZELL, HOW THE WEST GREW RICH: THE ECONOMIC TRANSFORMATION OF THE INDUSTRIAL WORLD 31–32 (1986) (discussing the role of organizational innovation in fostering the industrial revolution). For an excellent overview of the debate over the role of the corporation in economic growth that brings new empirical findings to bear, see Amanda G. Gregg, *Factory Productivity and the Concession System of Incorporation in Late Imperial Russia, 1894-1908*, 110 AM. ECON. REV. 401 (2020).

2. *See generally* REINIER KRAAKMAN ET AL., THE ANATOMY OF CORPORATE LAW (3d ed. 2017).

centralizing control, the corporate form was also a means for managing the increased complexity of producing at scale.[3]

Pursuing economies of scale is not the only strategy in a company's playbook, however. Pressure to innovate new marketable technology has pushed companies to adopt more collaborative modes of production, where a significant amount of activity occurs across firm boundaries rather than solely within them.[4] As a result, the corporate form is not the only primary tool of private law upon which modern capitalism relies. As production becomes more collaborative, the role of contracting becomes increasingly important.

The stakes for understanding this collaborative production model are high. When interfirm collaboration operates effectively, the gains can be dramatic. For instance, many of the medicinal breakthroughs of the 21st century have been achieved through collaboration between a promising biotechnology company and an established pharmaceutical company. At the same time, dysfunctional collaborations can have disastrous consequences, as commercial aerospace demonstrates. In the early 2000s, Boeing shifted to a collaborative design and production process in order to introduce carbon fiber technology in its 787 Dreamliner, hoping to incorporate the advanced material on a reduced timeframe and under budget.[5] What resulted, however, were a series of quality problems and cost overlays that continue to dog the Dreamliner to this day.[6] Another Boeing aircraft provides a far more troubling example: It appears that the software solution to the 737 MAX 8's tendency to pitch up that Boeing developed with external engineers

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3. *Id.*

4. During much of the twentieth century, innovation was often organized within the boundaries of a single firm. Many of the famous R&D centers of the mid-twentieth century—such as Bell Labs, Lockheed's Skunk Works, and Xerox's PARC—were found within the borders of a single firm. *See* ALFRED D. CHANDLER, JR., THE VISIBLE HAND: THE MANAGERIAL REVOLUTION IN AMERICAN BUSINESS 1–3 (1977) (describing the modern business enterprise and the recent move away from single-unit businesses). More recently, de-verticalized approaches to innovation have become a regular fixture in the contemporary economic order. Under pressure from dynamic, global markets, firms increasingly collaborate with one another to access and thereby leverage expertise they could not readily develop in-house. *See* Kathleen M. Eisenhardt & Claudia B. Schoonhoven, *Resource-Based View of Strategic Alliance Formation: Strategic and Social Effects in Entrepreneurial Firms*, 7 ORG. SCI. 136, 136 (1996) (detailing the rise of de-verticalization and cooperation within the economy); John Hagedoorn & Jos Schakenraad, *Inter-firm Partnerships and Co-operative Strategies in Core Technologies*, *in* NEW EXPLORATIONS IN THE ECONOMICS OF TECHNICAL CHANGE 3, 9–13 (C. Freeman & L. Soete eds., 1990); Kathryn Rudie Harrigan, *Joint Ventures and Competitive Strategy*, 9 STRATEGIC MGMT. J. 141, 142 (1988).

5. Christopher S. Tang & Joshua D. Zimmerman, *Managing New Product Development and Supply Chain Risks: The Boeing 787 Case*, 10 SUPPLY CHAIN F. 74, 74 (2009).

6. *See, e.g.*, Minda Zetlin, *In a Shocking Development, Safety Questions Arise About Another Boeing Jet. American and United Both Fly Them*, INC. (Apr. 23, 2019), https://www.inc.com/minda-zetlin/boeing-787-dreamliner-safety-issues-north-charleston-plant-debris-planes.html; Steve Denning, *The Boeing Debacle: Seven Lessons Every CEO Must Learn*, FORBES (Jan. 17, 2013, 7:24 AM), http://onforb.es/XcYsxn https://perma.cc/M48K-9XQP]; *Boeing 787 Dreamliner Hit by Landing Gear Glitch*, REUTERS (Nov. 8, 2011, 2:57 AM), http://www.reuters.com/article/2011/11/08/uk-boeing-dreamliner-glitch-idUSLNE7A603L20111108 [https://perma.cc/AX8A-UJTL]; Jason Paur, *NTSB Urges Action After Engine Failures in New Boeing 787, 747 Airliners*, WIRED (Sept. 17, 2012, 2:36 PM), http://www.wired.com/2012/09/ntsb-boeing-787-engines [https://perma.cc/Y5UG-GCVE]; *Airline Reports Problem with Hydraulic Pump in Dreamliner*, CHI. TRIB. (Sept. 16, 2013), http://articles.chicagotribune.com/2013-09-16/business/chi-dreamliner-hydraulic-pump-in-dreamliner-20130916_1_hydraulic-pump-the-dreamliner-overheating-batteries [https://perma.cc/ZYX7-E8R8]; Jad Mouawad, *Fuel Leak Is Latest Setback for Boeing's Dreamliner*, N.Y. TIMES (Jan. 8, 2013), http://www.nytimes.com/2013/01/09/business/fuel-leak-is-latest-setback-for-boeing-787.html?_r=0 [https://perma.cc/6SMX-KHTM].

was ineffective and ultimately caused the deaths of over 300 people.[7]

As a result, the increasing importance of contractual governance mechanisms in the modern economy has attracted a great deal of scholarly attention. The literature's foundation was laid in Macauley's landmark paper, which presented empirical evidence that flexibility in these contractual relationships is not achieved through formal legal doctrines but through informal norms.[8] Research on relational contracting has since flourished. Debate has focused upon a positive question that has important normative implications: What is the relationship between formal and informal contracting? Understanding whether formal and informal contracts are substitutes or complements to one another matters because it steers how we think about court intervention. For instance, if informal governance is a substitute for formal contracting, then judicial involvement may "crowd out" efficient informal institutions. On the other hand, if informal contracts complement formal agreements, then judicial intervention may be beneficial, although that will depend on the specifics of exactly how formal and informal agreements work together.

Within this literature Gilson, Sabel & Scott's ("GSS") trilogy of relational contracting papers, of which *Braiding: The Interaction of Formal and Informal Contracting in Theory, Practice, and Doctrine* is the core, stands out.[9] Their theory of "braided" contracting is the most ambitious of recent relational contracting efforts, because it attempts to explain behavior in a wide range of modern markets, engaging directly with the large, dynamic industries of the 21st century economy, rather than focusing solely upon niche trading communities. Braiding also carefully engages with the complexity of modern transactions—attempting to explain in detail how the elements of formal agreements interact with informal governance. Finally, braiding theory is an important part of GSS's broader attempt to outline the positive foundations for a non-unitary theory of U.S. contract law.[10]

The braiding thesis can be summarized as follows. GSS argue that collaborative innovation depends upon a unique blend of both formal contract provisions, enforceable in a court of law, and informal constraints, which rely upon extra-legal sanctions to police behavior.[11] In a braided agreement, certain formal contract provisions create information sharing routines, which in turn foster informal governance by (1) making each collaborator's performance more transparent, (2) revealing whether the parties are prone to cheating, and (3) locking the parties into the partnership as they make mutual investments in relationship-specific learning. This "braid" of formal and informal contracting harnesses the opportunism problems GSS see plaguing interfirm collaborations.

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7. Anurag Kotoky & Kyunghee Park, *Boeing's Grounded 737 Max—The Story So Far*, WASH. POST (July 9, 2019, 2:49 AM), https://www.washingtonpost.com/business/boeings-grounded-737-max-the-story-so-far/2019/07/08/5eb2e4be-a1e6-11e9-a767-d7ab84aef3e9_story.html [https://perma.cc/GBR2-Y85X].

8. Stewart Macaulay, *Non-Contractual Relations in Business: A Preliminary Study*, 28 AM. SOC. REV. 55, 64 (1963).

9. *See generally* Ronald J. Gilson et al., *Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration*, 109 COLUM. L. REV. 431 (2009); Ronald J. Gilson et al., *Braiding: The Interaction of Formal and Informal Contracting in Theory, Practice, and Doctrine*, 110 COLUM. L. REV. 1377 (2010); Ronald J. Gilson et al., *Contract and Innovation: The Limited Role of Generalist Courts in the Evolution of Novel Contractual Terms*, 88 N.Y.U. L. REV. 170 (2013).

10. Ronald J. Gilson et al., *Text and Context: Contract Interpretation as Contract Design*, 100 CORNELL L. REV. 23, 67–74 (2014).

11. *See* Gilson et al., *Contracting for Innovation*, *supra* note 9, at 476–89.

This paper, prepared for a conference celebrating Ron Gilson's impressive oeuvre, attempts to do two things. First, it provides an assessment of the braiding thesis by analyzing a market that has not yet attracted scholarly scrutiny to determine whether braiding explains the behavior observed. Second, it introduces areas where further theoretical and empirical work are needed to advance our understanding of how relational contracting works, thereby providing a roadmap for future research. The treatment throughout the essay is light, in an attempt to cover ground rather than drill down into discrete issues.

To assess the braiding thesis, the paper undertakes a circumscribed but illuminating exploration of a market with immense untapped opportunity: U.S. defense contracting. The U.S. government's acquisition of weapon systems is not only heavily outsourced but also technologically ambitious—a perfect combination for studying relational contracting. In particular, the paper studies a variation of braided contracting: The use of preliminary agreements in complex negotiations, here in the context of negotiations for the acquisition of advanced weapon systems. The question is simple: Do preliminary negotiations in defense contracting reflect the braiding thesis?

To provide some perspective, the paper first examines the available historical record relating to the negotiations for the development of the *USS Monitor* during the U.S. Civil War. The *Monitor* was a highly novel design that entailed a great deal of risk and a significant upfront investment—exactly the type of situation where precisely delineating the supplier's performance obligations would be impossible, and relational contracting would be necessary. The historical record is not substantial, but the first-hand account of one of the partners developing the *Monitor* is revealing. Negotiations were entirely informal, and personal relationships among U.S. Navy command and the partners developing the new vessel were key to securing each side's commitment. The negotiations for the *Monitor* are an example of classic relational contracting.

The paper then presents a far different arrangement known within the Department of Defense as "alpha contracting," which was introduced at the close of the 20th century. Modern sourcing negotiations typically follow an iterated process of arm's-length negotiations between the government and a prime contractor. The government defines the scope of the acquisition project with a statement of work and then builds a request for proposals based upon that statement. It then shares that request with multiple potential suppliers, who then formulate proposals in response. The government scrutinizes the proposals and selects a supplier, or small subset of suppliers, for final negotiations, and eventually an agreement is reached. It is a back-and-forth process where each side works alone.

Alpha contracting differs from that standard process by blending what were once arm's-length negotiations into a collaborative effort to develop the terms of the project. At the start, the government approaches a key supplier for the project, rather than sending the work out to bid. The government and supplier then jointly design the statement of work, the request for proposals, and the proposal itself. No longer are those elements developed in isolation. The teams designing those preliminary documents then negotiate the final agreement. Overseeing this entire process is a formal committee structure, jointly staffed with representatives from the government and the prime contractor. Major decisions and disputes are escalated to a management level committee, which also has visibility over the engineering teams cooperating on the technical development of the weapon system. Publicly available Department of Defense studies analyzing alpha contracting conclude

that the process builds trust between the government and the prime contractor teams as the structure leads them through the process of joint learning. In short, alpha contracting is the Department of Defense's version of braided preliminary agreements.

Alpha contracting is a particularly interesting example of the braiding thesis, because traditional informal sanctions are presumably readily available, but they are not relied upon. Alpha contracting is undertaken usually when the government single-sources a system, and frequently the prime contractor approached is one with a longstanding relationship with the government. That type of situation, where the two parties have had prior deals and, as a result, also have a strong expectation of future deals, is the sort of scenario where bilateral informal sanctions, such as the threat to cut a party off from future transactions, should have significant bite. That is the *Monitor* example in a nutshell. Yet, in alpha contracting the parties erect an elaborate formal structure for their preliminary negotiations, lending support to the braiding thesis's claim that formality complements informality, rather than substituting for it.

The paper then shifts to the new possible frontiers for relational contract scholarship. It uses the braiding thesis as a starting point, focusing upon a natural follow-on question to the analysis discussed above: What is the scope of the braiding thesis? When is braiding used, and when is it not? GSS take an important first step towards answering that scoping question in an important subsequent paper, *Text and Context: Contract Interpretation as Contract Design*, which situates braiding within a broader non-unitary theory of contract law.[12] That paper argues that braiding is one approach among many, and that a market's level of uncertainty and "thickness" will determine whether braiding or different contractual tools are used.[13] The final section of this paper builds upon the *Text and Context* argument by introducing additional possible determinants, not just market uncertainty and scale, that may provide a more nuanced understanding of when parties' use braiding mechanisms. Two possibilities are introduced: Alternative types of exchange hazards affecting transactions and the differing topologies of transactional networks in industries. Exploring how these considerations may affect governance decisions is an important task for future research.

II. HOW FORMAL AND INFORMAL CONTRACTS ADDRESS HOLD-UP RISK

A. 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. For investment to proceed, plans must be made, and there must be an expectation that those plans will be kept. 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 they need to engage in significant investments. On the other hand, because parties cannot fully anticipate future events, the formal agreements they design will be inevitably "incomplete"—*i.e.*, they will not fully allocate risks among the parties in all potential future states of the world. 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

12. Gilson et al., *Text and Context*, *supra* note 10, at 54–66.
13. *Id.*

discovery progresses.[14] In summary, it is common to frame the challenge of designing contracts as a tension between competing needs for certainty and flexibility.[15]

Contractual incompleteness can be particularly problematic in situations where investment in relationship-specific assets is required.[16] An exchange requiring such relationship-specific investments—*i.e.*, investments in assets that can only be sold in the alternative to third parties at a material discount—renders the investing party vulnerable to an opportunistic partner, who, knowing that the investing party is over a barrel, can "hold-up" the party as performance unfolds in order to secure a greater share of the contractual surplus.[17] A massive literature known as the Theory of the Firm examines the conditions under which integrating production within the boundaries of a single firm is a more efficient response than contracts to the threat of hold-up.[18]

B. The Possibility of a Binary Enforcement Network

Integrating production within the boundary of a single company is not the only solution to the problem of contractual incompleteness. Informal governance through social norms may also address the hold-up problem.[19] The key reason an informal form of enforcement may be effective is that commercial norms and trade usages may be more flexible than legal rules, allowing parties to transact in conditions of uncertainty because they know that those flexible norms will adjust as new market realities unfold. Further, informal enforcement may be more accurate than dispute resolution through public courts of law, because direct market participants and not generalist judges determine whether promises have been breached.[20]

Informal sanctions are typically available in markets where deals between contracting parties repeat. Repeated deals are the basis for bilateral sanctions: A repeat player can

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14. *See generally* Matthew Jennejohn, *The Private Order of Innovation Networks*, 68 STAN. L. REV. 281 (2016); Gilson et al., *Contracting for Innovation*, *supra* note 9.

15. *See generally* Herbert A. Simon, *A Formal Theory of the Employment Relationship*, 19 ECONOMETRICA 293 (1951).

16. *See generally* Benjamin Klein, *Why Hold-Ups Occur: The Self-Enforcing Range of Contractual Relationships*, 34 ECON. INQUIRY 444 (1996); Benjamin Klein et al., *Vertical Integration, Appropriable Rents, and the Competitive Contracting Process*, 21 J.L. ECON. 297 (1978).

17. *See generally* Klein et al., *supra* note 16; Oliver Hart & John Moore, *Foundations of Incomplete Contracts*, 66 REV. ECON. STUD. 115 (1999).

18. Coase's seminal paper is widely recognized as the origin of this literature, although the specific threat of opportunistic hold-up is conspicuously absent in the piece. *See generally* R. H. Coase, *The Nature of the Firm*, 4 ECONOMICA 386 (1937); Ronald Coase, *The Conduct of Economics: The Example of Fisher Body and General Motors*, 15 J. ECON. MGMT. STRATEGY 255 (2006). Later work would focus the field's attention on hold-up threats. Klein et al., *supra* note 16; OLIVER E. WILLIAMSON, THE ECONOMIC INSTITUTIONS OF CAPITALISM (1985); OLIVER E. WILLIAMSON, THE MECHANISMS OF GOVERNANCE (1996); Oliver Hart, *Hold-up, Asset Ownership, and Reference Points*, 124 Q.J. ECON. 267 (2009).

19. Barak D. Richman, Essay, *Firms, Courts, and Reputation Mechanisms: Towards a Positive Theory of Private Ordering*, 104 COLUM. L. REV. 2328, 2357–62 (2004).

20. *See* Lisa Bernstein, *The Questionable Empirical Basis of Article 2's Incorporation Strategy: A Preliminary Study*, 66 U. CHI. L. REV. 710, 714–17 (1999) (providing empirical evidence that private, industry-specific dispute resolution is preferred over the Uniform Commercial Code's strategy of incorporating trade usage into the interpretation of contractual terms undertaken by a court); *see generally* Clive Bull, *The Existence of Self-Enforcing Implicit Contracts*, 102 Q.J. ECON. 147, 153–57 (1987) (demonstrating how informal contracts can effectively govern labor relationships in the absence of formal agreements).

credibly threaten to end a commercial relationship, which discourages bad behavior.[21] Or, a repeat player can credibly threaten to disparage a poorly behaving counterparty's reputation in the market.[22] In either case, it is the prospect of sanctions being applied in a subsequent transaction that disciplines behavior in the current deal. In his classic work on medieval Maghribi merchants, Greif refers to this as "intertransactional linkage."[23] Linking transactions through repeated dealings between two parties creates the stability required for consistent norms to emerge[24] and allows an aggrieved party to punish an opportunistic counterparty either by terminating the relationship or spreading word of their malfeasance.[25] In summary, the answer to the hold-up problem may be extra-legal.

C. Informal Governance as a Substitute for Formal Law

A key question in the literature on relational contracting is determining the relationship between formal and informal agreements. Early work on relational contracting often answered that question simply and starkly: They are substitutes for one another. Formal agreements are stuffed in filing cabinets never to see the light of day again, and what matters is the informal "law in action."[26] This substitutionary relationship arises because formal enforcement is understood to "crowd out" informal social norms. This view is rooted in Macauley's original study, and reinforced in Williamson's work, where discrete contracts enforced through formal contract law and "hybrid" relational contracts enforced through informal sanctions are categorically separate options.[27] In situations where industry players are better able to assess evidence of contractual breach than courts, rational parties will employ relational contracts in lieu of formal enforcement where the contracting parties have better information than a third party enforcer.[28] A wide body of scholarship, anchored by Bernstein's early work, has found evidence of a preference for informal enforcement over formal adjudication in a number of commodity markets.[29] Quantitative studies have also found a negative relationship between formal contracts and stronger social capital.[30]

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21. Peter Moran, *Structural vs. Relational Embeddedness: Social Capital and Managerial Performance*, 26 STRATEGIC MGMT. J. 1129, 1131, 1134 (2005); Macaulay, *supra* note 8, at 63; Ian R. Macneil, *Contracts: Adjustment of Long-Term Economic Relations Under Classical, Neoclassical, and Relational Contract Law*, 72 NW. U. L. REV. 854, 898–99 (1978).

22. Lisa Bernstein, *Opting out of the Legal System: Extralegal Contractual Relations in the Diamond Industry*, 21 J. LEG. STUD. 115, 149 (1992).

23. AVNER GREIF, INSTITUTIONS AND THE PATH TO THE MODERN ECONOMY: LESSONS FROM MEDIEVAL TRADE 47–50 (2006).

24. *Id.* at 59.

25. *See* L. G. Telser, *A Theory of Self-Enforcing Agreements*, 53 J. BUS. 27, 27–28 (1980) (discussing how a threat to terminate a trading relationship can enforce informal agreements); W. Bentley MacLeod, *Reputations, Relationships, and Contract Enforcement*, 45 J. ECON. LIT. 595, 595–97 (2007) (discussing the role of reputational sanctions in enforcing informal agreements).

26. Macauley, Braucher, Kidwell and Whitford's innovative contracts casebook is a classic example of one of the central thrusts of the relational contracting literature, which emphasizes the law in action rather than just formal judicial decisions. *See* STEWART MACAULEY ET AL., CONTRACTS: LAW IN ACTION (3d ed. 2010).

27. Macauley, *supra* note 8; WILLIAMSON, *supra* note 18, at 70.

28. Clive Bull, *The Existence of Self-Enforcing Implicit Contracts*, 102 Q.J. ECON. 147, 148–49 (1987).

29. ROBERT C. ELLICKSON, ORDER WITHOUT LAW: HOW NEIGHBORS SETTLE DISPUTES (2009); Lisa Bernstein, *Opting Out of the Legal System: Extralegal Contractual Relations in the Diamond Industry*, 21 J. LEGAL STUD. 115, 148–50 (1992).

30. *See, e.g.*, David T. Robinson & Toby E. Stuart, *Network Effects in the Governance of Strategic*

D. Invoking Informal Governance via the Formal Contract

In recent years, a number of papers have challenged the conventional wisdom that informal and formal contracts are substitutes for one another. This theory, which has origins in Macneil's work and was further developed by Scott, understands the formal contract as the mechanism by which parties select between formal and informal enforcement.[31] In situations where uncertainty often makes future performance obligations difficult to foresee, parties use standard-like terms, such as "best efforts" provisions, in their agreements. These types of terms build flexibility into the exchange relationship and, in the event of litigation, they invite more searching inquiries of the relational context of an exchange. In that respect, the formal contract is the mechanism by which relational governance is incorporated in the transaction.

This approach, where the terms of the formal agreement are a source of flexibility in the transaction and, in turn, guide an enforcement court's interpretive mode, has an important implication. Parties do not necessarily have to choose absolutely between formality and informality in enforcement; instead, they can use the formal agreement as the basis for combining them. Formal and informal governance are complements to one another, not substitutes.

In their braiding paper, GSS build upon this approach by focusing upon high uncertainty situations, where it is difficult for parties to pin down performance obligations in formal contracts and they also lack repeated deals and strong industry connections. In such situations, given the limits of both formal and informal contracting, we would expect most economic activity to be integrated within the boundaries of a single firm. Yet, parties routinely organize such activity through contracts.

GSS argue that, in situations where social capital is low because deals do not repeat between parties, particular types of provisions in formal contracts can approximate the rich information sharing necessary for informal governance to operate. In GSS's telling, a number of novel formal contract mechanisms are used in collaboration agreements to, in a sense, artificially manufacture the prerequisites for informal constraints. They posit that these formal mechanisms are unenforceable in court, which then raises the question of why they are included in the contract at all.[32] GSS argue that these mechanisms render private information observable, screen for opportunistic counterparties, and increase the costs parties would incur when switching to another partner, thereby facilitating informal governance mechanisms that harness holdup problems.[33] In that way, the contract forms a braid that interweaves informal and formal governance.[34]

The central strand of the braid is a unique set of contract mechanisms. First, the

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Alliances, 23 J.L. ECON. & ORG. 242, 242 (2007) (arguing that "the stock of prior alliances between participants in the biotechnology sector forms a network that serves as a governance mechanism").

31. Ian R. Macneil, *A Primer of Contract Planning*, 48 S. CAL. L. REV. 627, 690, 704 (1975); Charles J. Goetz & Robert E. Scott, *Principles of Relational Contracts*, 67 VA. L. REV. 1089, 1091, 1095 (1981); Charles J. Goetz & Robert E. Scott, *The Limits of Expanded Choice: An Analysis of the Interactions Between Express and Implied Contract Terms*, 73 CAL. L. REV. 261, 278 (1985); Robert E. Scott & George G. Triantis, *Anticipating Litigation in Contract Design*, 115 YALE L.J. 814, 841–42, 844–45 (2005).

32. Gilson et al., *Contracting for Innovation*, *supra* note 9, at 488.

33. Gilson et al., *Braiding*, *supra* note 9, at 1403.

34. *See* Gilson et al., *Contracting for Innovation*, *supra* note 9, at 448–58 (stating that the conventional contract theory cannot explain the development of networks of explicit contracts among collaborating firms and a formal governance mechanism is required).

contracts require both parties to invest in relationship-specific information and structure that investment through adaption protocols, such as formal plans, process guidelines, codesign requirements, etc.[35] Second, these contracts include what GSS refer to as the "contract referee" mechanism—such as a committee with unanimous decision-making requirements and dispute escalation processes, which are understood as tools that reveal information symmetrically between the collaborating parties.[36]

The unanimity requirement allows a party to demand more information from a partner, while escalation serves a disciplinary function by requiring lower-level executives to share information in good faith.[37] As parties invest in information specific to their collaboration, their switching costs (*i.e.*, the cost of replacing a counterparty) also increase, which acts as a further constraint on opportunistic behavior.[38] Finally, GSS argue that this information sharing screens out partners who are "naturally opportunistic"—starting to share information gives a party insight into its counterparty's predilection for fair dealing.[39] In short, formal contracts bring otherwise unobservable information out into the open, allowing for effective informal governance of those relationships. By doing so, the formal provisions of the contract complement and, in a way, manufacture informal constraints; that, in turn, allows parties to benefit from the flexibility of informal governance in environments otherwise not conducive to reputation effects, trust, or the prospect of repeated dealing.[40]

With respect to its normative implications, the braiding thesis is largely a self-enforcement theory of contract. Court enforcement is presumed to have limited efficacy, and the focus of much of the analysis is on how parties can solve their own problems without recourse to the courts.[41] For example, in GSS's model, the braiding mechanisms are designed to render information observable between the parties; they are not means for facilitating verification by an enforcement tribunal. On this view, courts only play a role by enforcing the information exchange regime, not taking the next step of vindicating parties' expectations.[42] To do so, GSS argue that courts should take a minimalistic, or "low-powered," approach when called upon to enforce contracts governing collaborative innovation.[43] In practice, this means disciplining blatant breaches of information exchange obligations with damages limited to reliance costs.[44] Because it is difficult for a court to assess parties' performances in an environment of continuous uncertainty, where parties' intentions are inchoate and subject to revision,[45] determining what qualifies as success or failure per the terms of the contract and, in turn, an aggrieved party's expectations will be

35. *Id.* at 476–78.
36. *Id.* at 479–81.
37. *Id.* at 480–81.
38. Gilson et al., *Contracting for Innovation*, *supra* note 9, at 481–86.
39. *Id.* at 481, 486–89.
40. Gilson et al., *Braiding*, *supra* note 9, at 1398–1403.
41. For example, Bozovic and Hadfield's "scaffolding" model presumes that formal enforcement is unnecessary for formal contract terms to play a role; rather, contract doctrine plays a referential role, used by the parties but not applied by a court. Gillian Hadfield & Iva Bozovic, *Scaffolding: Using Formal Contracts to Support Informal Relations in Support of Innovation*, 2016 WIS. L. REV. 981, 987 (2016).
42. Gilson et al., *Braiding*, *supra* note 9, at 1415–16.
43. *Id.*
44. *Id.* at 1416.
45. *Id.* at 1415–16.

difficult.[46] Verifiability is an acute problem.[47] Thus, GSS recast neoformalist arguments for minimalist contract enforcement as a tool for protecting the braided governance mechanism.[48]

III. PRELIMINARY AGREEMENTS IN DEFENSE ACQUISITIONS

Does empirical analysis confirm the braiding thesis? This is a difficult question to answer in the sense that most relational contracting is outside of the public eye. This paper undertakes a preliminary analysis of one market that does have a significant amount of public exposure, at least with the respect to the general contours of deals: Defense contracting. Sourcing weapons and materiel from private suppliers has been the U.S. government's strategy since its inception, when internal capacity to develop and produce armaments was non-existent. The U.S. Department of Defense ("DoD") has continued that outsourcing strategy as the defense requirements of the country have grown, undertaking significant efforts, such as developing a deployable atomic weapon or the Saturn V rocket, through a partnership model that relied extensively upon external expertise. Particularly where advanced weapon systems are being developed, relational contracting should be common.

Specifically, this section of the paper analyzes how preliminary negotiations in defense acquisitions are structured. Preliminary agreements—devices such as memoranda of understanding and letters of intent that memorialize an incomplete set of terms that the parties have agreed upon—are frequently used in many commercial transactions. Schwartz & Scott's influential work argues that preliminary agreements are used to manage hold-up risk as parties make relationship-specific investments in the negotiation of an uncertain, complex transaction.[49] GSS extend braiding to preliminary agreements, arguing that the braiding logic provides a justification for court's regular use of low-powered sanctions when enforcing preliminary agreements.[50]

One of the struggles with extending braiding to preliminary agreements is a lack of some of the key indicia of braiding that GSS identified in technology transactions, which formed the empirical heart of their thesis. Timeframes are obviously compressed in the preliminary negotiation context compared to an ongoing collaboration to develop new technology.[51] More importantly, formal routines for information sharing—such as the jointly staffed committees responsible to craft a trajectory for a collaboration that we often see in the context of jointly developing new technology—are not commonly observed.

This section of the paper shows that the formal braiding structures observed in the technology context are, in fact, observed in preliminary negotiations, strengthening the case that preliminary agreements can be understood through the braiding lens. The DoD negotiations for the acquisition of advanced weapon systems at times employ a process

46. Gilson et al., *Contracting for Innovation*, *supra* note 9, at 455–57.

47. *See supra* note 20.

48. For a concise statement of the neoformalist position, see Robert E. Scott, *The Case for Formalism in Relational Contract*, 94 NW. U. L. REV. 847, 851–52, 851 n.11 (2000).

49. Alan Schwartz & Robert E. Scott, *Precontractual Liability and Preliminary Agreements*, 120 HARV. L. REV. 661, 665–67 (2007). Subsequent research takes a broader view of the exchange hazards that preliminary agreements may address. *See, e.g.*, Cathy Hwang, *Deal Momentum*, 65 UCLA L. REV. 376 (2018); Albert Choi & George Triantis, *Designing and Enforcing Preliminary Agreements*, 98 TEX. L. REV. 439 (2020).

50. Gilson et al., *Braiding*, *supra* note 9, at 1424.

51. *Id.* at 1431.

called "alpha contracting" that includes many of the common markers of braiding contracts. It replaces an arm's length negotiation process with a formal structure that shapes a collaborative approach to defining the terms of the joint project, much like the formal institutions we see in braided contracts.

To provide context for alpha contracting, this section of the paper first presents a brief analysis of how preliminary negotiations for the development of highly uncertain weapon systems were handled in an earlier era. A small but illuminating collection of correspondence from one of the partners who developed the *USS Monitor* during the U.S. Civil War opens a window on how defense contracting for advanced technology was undertaken at that time. The risks shouldered by the parties investing in a relationship prior to the memorialization of a final contract were addressed entirely through informal means, such as reputation effects. As we will see, the *Monitor* experience casts the later development of alpha contracting in sharp relief.

A. Relying on Reputation Effects: Negotiating the Contract for the U.S.S. Monitor in 1862

Informal, personal relationships were all that held together the negotiations leading up to the U.S. Navy's award of a contract to John Ericsson and his partners for the development and construction of the *USS Monitor*, the ironclad ship that famously fought the *CSS Virginia* (Merrimack) to a draw in Hampton Roads during the U.S. Civil War. In early 1862, Cornelius Bushnell, a wealthy Connecticut investor, approached the Navy with Ericsson's initial designs for the *Monitor*.[52] The Secretary of the Navy reacted positively to the designs and encouraged Bushnell to meet with the Naval Board, which had been established in 1861 to review ironclad vessel proposals.[53] Bushnell secured commitments from two additional investors who had "large acquaintance with Government authorities" and then presented the plans to the Naval Board in Washington.[54] A preliminary meeting with a few members of the Board and President Lincoln went well, but the meeting with the full Board the following day was difficult for Bushnell.[55] Ericsson had previously developed a steam ship for the Navy, the *USS Princeton*, which experienced a gun misfire that killed a number of officers, and some members of the Board did not want to risk another embarrassing failure.[56] Bushnell returned to New York to convince Ericsson to make the case for his design to the Naval Board in person.[57] Ericsson did so, promised to build the ship for $275,000 in 100 days, and the Board verbally awarded the contract.[58]

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52. WILLIAM S. WELLS, THE ORIGINAL UNITED STATES WARSHIP "MONITOR": COPIES OF CORRESPONDENCE BETWEEN THE LATE CORNELIUS F. BUSHNELL, CAPTAIN JOHN ERICSSON, AND THE HON. GIDEON WELLES, SECRETARY OF THE UNITED STATES NAVY, TOGETHER WITH A BRIEF SKETCH OF MR. BUSHNELL'S LIFE 12, 14 (1899); *see also* WILLIAM H. ROBERTS, CIVIL WAR IRONCLADS: THE U.S. NAVY AND INDUSTRIAL MOBILIZATION (2002) (discussing the development of technology in the Navy during the Civil War); Early J. Hess, *Northern Response to the Ironclad: A Prospect for the Study of Military Technology*, 31 CIV. WAR HIST. 126 (1985) (discussing the historiography of military technology).

53. WELLS, *supra* note 52, at 12.

54. *Id.* at 21.

55. *Id.* at 14.

56. *Id.* at 26. Bushnell also had a prior history with the Naval Board—he was the promoter of an alternative design, which was one of three winning proposals in 1861 and was eventually built as the U.S.S. Galena. *Id.* at 18.

57. *Id.* at 27.

58. WELLS, *supra* note 52, at 29.

The following day, on the basis of the Navy's verbal commitment, Bushnell and Ericsson entered into contracts with suppliers and with a shipbuilder in Greenpoint, Brooklyn.[59] As news of the award travelled, competitors to Ericsson's design raised a "great clamor," criticizing the Naval Board for awarding the business to Ericsson.[60] In response, the Board sprung a new demand on the partners, insisting upon a guarantee provision in the contract that required Bushnell, Ericsson, and their other partners to refund all payments to the Navy if the ship proved unsuccessful.[61] This was a difficult demand for the partners, because it shifted all execution risk entirely to them.[62] This moment is where informal contracting comes to the fore. It appears that the partners were sufficiently comforted by one of the members of the Naval Board, who was in charge of shipyards, and assured them that the Navy "never intended that [they] should suffer."[63] In other words, it appears that there was an informal side agreement taking some of the sting out of the guarantee provision.[64] The formal contract, which included the guarantee provision, was executed shortly thereafter, and the rest is history.[65]

B. Braiding in Preliminary Negotiations: "Alpha Contracting" at the Close of the 20th Century

By the close of the 20th century, many aspects of the DoD's sourcing process would be wholly alien to Bushnell and Ericsson, were they to observe it. First of all, unlike the informal contracting that supported the *Monitor's* development, sourcing negotiations are highly formalized. The DoD's standard acquisition process for advanced weapon systems involves a structured exchange of information between the DoD and a prime contractor. First, the DoD prepares a "statement of work," which defines the deliverables for the project it is putting out for contract.[66] Once the statement of work is defined, the DoD will then issue a formal request for proposals to its suppliers.[67] Interested suppliers may submit questions to the DoD but otherwise develop their proposals in isolation.[68] When the supplier's formal proposal is finalized, it sends it to the DoD, which evaluates the proposals it has received, verifying them through an internal "fact-finding" review.[69] The DoD then negotiates the terms of the contract with a finalist, and upon execution of the agreement, the parties begin performing.[70]

Furthermore, in situations of high uncertainty, such as where new technology is being

59. *Id.* at 35. Eight different subcontractors manufactured the key sub-systems, which were shipped to Greenpoint for assembly. *Development, Design & Construction*, USS MONITOR CTR., https://www.monitorcenter.org/creating-the-monitor/ [https://perma.cc/PPF5-KCJ6] (last visited Feb. 20, 2020).

60. WELLS, *supra* note 52, at 15.

61. *Id.*

62. *Id.*

63. *Id.*

64. It seems most likely that the Navy's compensation to the partners would be in the form of contracting opportunities for different types of vessels.

65. *The Monitor Contract*, USS MONITOR CTR., https://www.monitorcenter.org/creating-the-monitor/ [https://perma.cc/PPF5-KCJ6] (last visited Feb. 20, 2020).

66. Mark Nissen, *Contracting Process Innovation* 9 (Naval Postgraduate Sch. Paper NPS-GSBPP-01-001, 2001), https://apps.dtic.mil/dtic/tr/fulltext/u2/a391124.pdf [https://perma.cc/6FN9-UVWE].

67. *Id.*

68. *Id.*

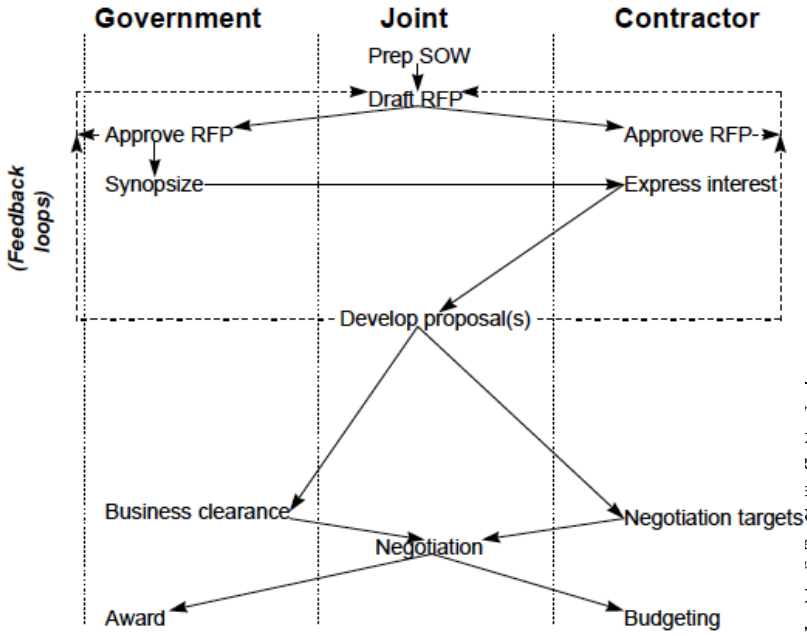
69. *Id.*

70. *Id.*

developed, the sourcing process is significantly collaborative. Instead of iterating the exchange of information in the arm's length process described above, the DoD has developed a process referred to as "alpha contracting," where the DoD and a prime contractor work together to define the terms of the project.[71] Alpha contracting has been used in situations where the DoD has chosen to single source the supply of the system, rather than relying upon two or more suppliers.[72]

The alpha contracting process begins with a different starting point. Rather than a statement of work that the DoD defines, the process begins with the DoD providing a "statement of objectives" that "prescribes only high-level goals for a system, as opposed to the work to be done."[73] Based on the statement of objectives, the prime contractor and the DoD, together, then develop the statement of work.[74] The DoD and prime contractor also jointly develop the request for proposals.[75] Finally, the DoD and prime contractor collaborate on the proposal itself, essentially eliminating the need for the DoD to undertake a standalone fact-finding review of the contractor's proposal. Once the proposal is finalized, the parties negotiate the terms of the formal agreement that will govern the sourcing relationship.[76] The flowchart in Figure 1 below, taken from a publicly available analysis originally prepared for the Navy Postgraduate School, illustrates the collaborative aspects of the alpha contracting process.[77]

Figure 1: Alpha Contracting Process Flow



71. *ntracting*
Experien *om Three*
Perspect TADUATE
SCH. (2(*cedents,*
Processe ɔ. Meier,
Best Pro *elligence*
and Defe *he Alpha*
Contract *)) Within*
Selected , Thesis, *Acquisition Reform through Alpha Contracting*, NAVAL POSTGRADUATE SCH. (2002).

72. Nissen, *supra* note 66, at 9.

73. *Id.* at 10.

74. *See id.* at 10–11 (providing an overview of alpha contracting, including "[t]echnical personnel from both the government PMO and contractor organization work together to develop the draft SOW").

75. *Id.*

76. *Id.*

77. Nissen, *supra* note 66.

That collaborative process for designing the terms of a sourcing relationship comes with a formal infrastructure. A number of committees are used to ground the process. To see how these committees underpin the alpha contracting process, consider the following brief case study, which puts them in context.[78]

In the late 1980s, the U.S. Navy and Air Force identified a need for a missile capable of striking a variety of ground targets from "standoff" range, meaning that they can be launched at a distance unreachable by defensive fire.[79] The program, which came to be referred to as the Joint Stand-Off Weapon ("JSOW"), required significant technological advances while also facing a challenging federal budget environment.[80] As a result, the Navy focused upon leveraging supplier expertise:

> [T]he JSOW team . . . concentrate[ed] on systems performance specifications in lieu of detailed design "specs," and encourage[ed] contractors to provide innovative approaches and solutions to problems, technical and affordability alike. For example, several of the contractors responding to RFIs proposed the current aerodynamically-efficient *glide* weapon (*i.e.*, engineless system) design to reduce cost while still meeting standoff mission requirements.[81]

As the early discussions around the project progressed, the government grew comfortable moving forward with a single supplier and chose to sole source the weapon development.[82] This allowed the government to bring the supplier into the design process, which in turn intensified the need for coordination between the supplier's teams, the Navy, and the Air Force. Thus, the government shifted from a standard contracting arrangement to the alpha contracting process described above.[83]

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78. Mark Nissen, *JSOW Alpha Contracting Case Study*, FED'N AM. SCIENTISTS (1997), https://fas.org/man/dod-101/sys/smart/docs/jsowcase.htm [https://perma.cc/AFA9-FZXD].

79. *Id.*

80. *Id.* ("Required mission capabilities for standoff launch range, day/night/adverse-weather operation, autonomous interdiction, in-flight navigation, terminal guidance, high kill probability, robust availability and other key performance parameters (KPPs) make the JSOW design a significant challenge, particularly with respect to its aggressive and strict cost goals. In fact, early estimates suggested that cost for such a weapon system would be several times higher than the established program goals, in order to achieve the full planned functionality and efficacy (i.e., satisfy the KPPs). This persistent and difficult focus on affordability has driven the program down a path of aggressive and progressive acquisition strategy and execution, which has involved a combination of competition and cooperation.").

81. *Id.*

82. *Id.* at 3–4.

83. Nissen, *supra* note 78, at 4.

The government introduced a "thermometer chart" that gave more structure to the statement of objectives as the parties worked together in developing the statement of work.[84] The chart differentiated between "must have" items that were non-negotiable for the Navy/Air Force and items that were subject to joint development.[85] For instance, the number of missiles the government was to buy on an annual basis was fixed by law, and therefore not subject to alteration.[86] The chart also identified the cost-improvement curve that the supplier would have to surpass in order to achieve the project's affordability goals, creating pressure that pushed government and supplier to introduce new technology and processes to achieve continual improvement.[87] The chart then identified the items that were subject to joint development, thereby serving as a device for focusing the government and supplier teams on where to focus their collaborative efforts as the development process proceeded.[88]

Working together on defining and revising those jointly developed items on the thermometer chart over the course of the process was subject to a system of "engineering-style" control.[89] That is, the government and supplier used a process known as "configuration management," which is commonly employed to engineer complex systems, not just to the technical development of the JSOW but also to the contracting process itself.[90] In short, the preliminary negotiations of the contracts were managed like a complex piece of technology.

Configuration management involves, among other things, the creation of a team responsible for managing the flow of proposed changes across all aspects of the system. In the JSOW case, this involved the creation of a "Contract Change Board," which managed the development of the government's request for proposal ("RFP") that would eventually form the basis of the final agreement. The Contract Change Board's origin in engineering practices was described by an observer as follows:

> [W]hen a weapon system is being developed . . . and later produced, the system is defined in terms of a baseline configuration that is clearly articulated and widely disseminated. Once the baseline configuration has been defined, the key to this process involves the control over changes to the missile design. One well-intentioned structural change to a section of the missile (e.g., that changes the outer mold line) may have unintentional consequences in one or more other areas (e.g., aerodynamics, observability) that are beyond the purview of the structural engineer. To guard against such inadvertent consequences, nearly every well-managed engineering organization institutes a Change Control Board (CCB) to review and approve every change to the baseline configuration. The CCB is generally comprised of an inter-disciplinary set of representatives from every functional area who meet periodically to jointly review proposed changes and prevent their unintended side effects.
>
> The application of this [configuration management] technique to the contracting

84. *Id.* at 9–10.
85. *Id.* at 10.
86. *Id.*
87. *Id.*
88. Nissen, *supra* note 78, at 10–11.
89. *Id.* at 11.
90. *Id.*

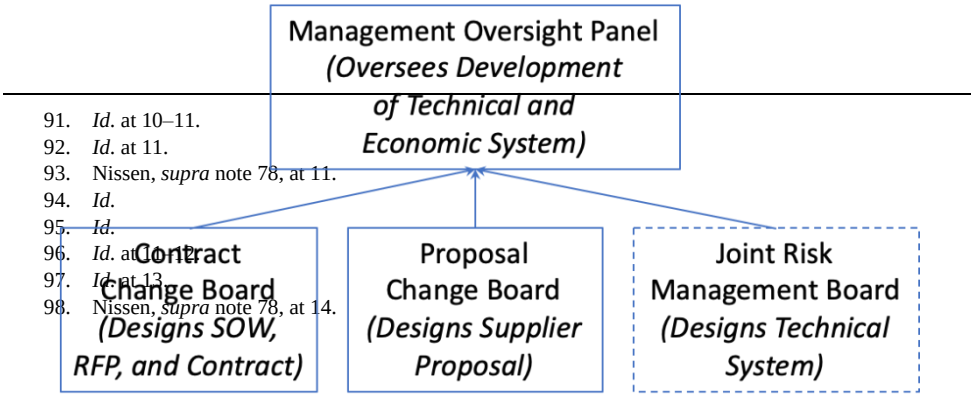
> process is similar in terms of objectives and procedures. The fundamental difference is that the "configuration" to be baselined and controlled pertains not to a missile, software system or other technical design; rather, the baseline to be controlled is the *RFP* which later evolves to become the final contract. In other words, once the draft RFP has reached a state at which the government and contractor agree that it is representative of their goals and intentions for the program, they create and disseminate a baseline, and then require any subsequent changes to be approved by a contractual variant of the CCB, "Contract Control Board" in this case. *Anyone*, [the Program Manager], [Contracting Officer], Systems Engineer, Cost Analyst, contractor, etc., wanting to make a change to the RFP/contract must submit a request and obtain approval from the *joint* CCB before the change is implemented into the baselined RFP.
>
> . . .
>
> Clearly both the government and contractor should be represented on this board, for in the joint process of developing the SOW, RFP, proposal and contract, people from both organizations share the responsibility for composing reviewing and coordinating these complex and dynamic contractual documents.[91]

In the case of the JSOW project, the government and prime contractor each had five key representatives on the board, supported by several other individuals from time to time.[92]

Parallel to the Contract Change Board was the Proposal Change Board, which manages the joint development of the supplier's proposal.[93] The Proposal Change Board shared common members with the Contract Change Board and followed similar decision procedures.[94] The key difference was that the Proposal Change Board focused upon cost estimates that are traditionally proposed by the supplier, while the Contract Change Board focused upon the RFP's non-price elements.[95]

Overseeing both boards was the Management Oversight Panel, which included higher level officers from both the Navy and the Air Force and executives from the prime contractor.[96] Critical information and issues are escalated to the Management Oversight Panel, which also operates on a collaborative basis like the boards below.[97] The Management Oversight Panel also participates in other aspects of the development process, including oversight of technical teams, and does not solely focus upon contracting matters.[98] This gives the Management Oversight Panel a panoramic view of the program's progress.

Figure 2: Joint Committee for the JSOW Development Program



91. *Id.* at 10–11.
92. *Id.* at 11.
93. Nissen, *supra* note 78, at 11.
94. *Id.*
95. *Id.*
96. *Id.* at 12.
97. *Id.* at 13.
98. Nissen, *supra* note 78, at 14.

Assessments of the alpha contracting process indicate that one of its leading benefits is increased trust among team members on both sides of the negotiation:

> [T]rust-based relationships that are developed in the alpha contracting process and carry over to improve the character of work and atmosphere of cooperation that follows from contracting into program execution . . . . The alpha contracting process appears to help foster such partnership before the execution phase of the program begins . . . . [Referring back to the organizational learning points above,] [t]his benefit can effectively help to move the government-contractor team along the . . . learning curve through joint participation, coordination and work in the contracting phase.[99]

That development of trust as the parties engage in joint learning is consistent with the logic of the braiding thesis. The formal agreement in a sense *manufactures* trust between the contracting parties. In that respect, formality complements informality.

IV. ADVANCING THE THEORY OF CONTINGENT MARKET INFRASTRUCTURE

The additional evidence of braided contracting introduced above underscores the importance of this form of economic organization. However, it also highlights a related question: How does braiding fit within the broader suite of contracting practices employed in the current economy? Not all contracts are braided, after all.

This Part first reviews GSS's answer to that question. They argue the limits of the braiding thesis are defined by the two characteristics of the markets in which parties transact: The level of uncertainty affecting transactions in that market and the scale of the market. Depending upon those two factors, braiding will thrive in some markets, while different contractual tools will be used in other markets.

This Part raises the possibility that other factors may also drive parties' choices to use braided agreements. First, it notes that the braiding mechanisms discussed above may address other exchange hazards and not just hold-up problems. A larger menu of exchange hazards expands the valence of an agreement, which leads to a more nuanced approach to the use of formal contract mechanisms. In other words, if braiding mechanisms respond to multiple exchange hazards, fluctuations in their intensity will have subtle effects on parties' decision to braid or not that current theory does not capture.

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99. *Id.* at 15.

Second, this Part notes that industry networks may also affect the use of braiding. Recent work by Bernstein and by Porat & Scott suggests this possibility by arguing different markets have different network structures, which may affect how contract law enforces the agreements in those markets.[100] This Part of the paper takes that idea a step further by raising the possibility that network structure may also provide a more fine-grained approach to understanding the limits of braiding, however. The intensity of certain types of exchange hazards, particularly technological spillovers, may differ materially for members in an industry depending upon the structure of the network.

A. Braiding's Place in a Non-Unitary Theory of Contract

GSS argue that market characteristics define the limits of braiding. Their starting point is Scott and Triantis' theory that parties can shift costs between ex ante design and ex post enforcement by choosing between rules and standards in their agreements.[101] Including a rule-like term in a contract may require a significant investment—one may have to retain expensive advisors, for instance, to predict future contingencies—but reduces back-end litigation costs—the court has clear, detailed contractual text to interpret and apply. On the other hand, including a standard-like term may reduce upfront drafting costs but increase litigation costs.

GSS take this a step further by connecting the choice between rule-like terms and standard-like terms to the general characteristics of a market.[102] The two key characteristics are the level of uncertainty affecting transactions in the market and the scale of the market. In situations where uncertainty is low, parties tend to use rule-like terms because they can more readily anticipate future contingencies, and it is comparatively cheap to define those highly specified terms. In turn, these markets tend to prefer textualist contract interpretation. In situations of high uncertainty but significant scale—*i.e.*, where courts encounter many disputes involving these high uncertainty transactions—parties use standard-like terms, because they have some comfort that the court's familiarity with the deal type will reduce litigation costs. GSS also introduce a third possibility: In situations of high uncertainty but low scale, such as the highly idiosyncratic transactions that characterize collaborative innovation, parties use braiding mechanisms that establish formal processes for information sharing. In this situation, GSS argue that textualism is most appropriate, because courts are ill-equipped to ascertain parties' expectations, which are inchoate, in such transactions.[103] In short, there is a humped, non-linear relationship between uncertainty and interpretive regime, as depicted in Figure 3 below.

Figure 3: The Relationship Between Contractual Uncertainty and Interpretive

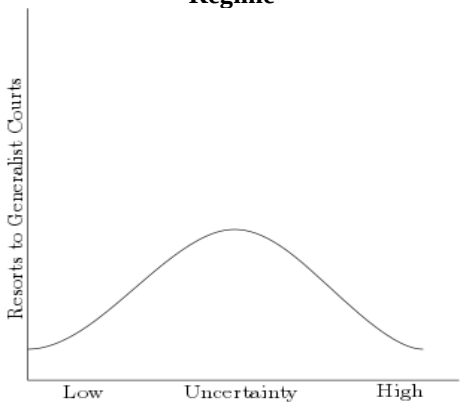
100. *See generally* Lisa Bernstein, *Beyond Relational Contracts: Social Capital and Network Governance in Procurement Contracts*, 7 J. LEGAL ANALYSIS 561, 561–62 (2015) (arguing that "highly interconnected firms" are able to accomplish success); Lisa Bernstein, *Contract Governance in Small-World Networks: The Case of the Maghribi Traders*, 113 NW. U. L. REV. 1009, 1014–15 (2019) (studying how an eleventh century merchant group's success translates to modern markets); Ariel Porat & Robert E. Scott, *Can Restitution Save Fragile Spiderless Networks?*, 8 HARV. BUS. L. REV. 1, 21 (2018) (determining the legal system could foster success for firm networks).

101. Scott & Triantis, *supra* note 31, at 822–35.

102. *See generally* Gilson et al., *Contracting for Innovation*, *supra* note 9 (arguing that changes in firm boundaries allow for innovation in contracting).

103. *Id.* at 66–67.

Regime[104]



To provide a sense of what that non-monotonic relationship means in practice, GSS point to paradigmatic markets frequently studied in private law scholarship. For instance, GSS see the niche commodity markets studied in Bernstein's early papers as low uncertainty environments. In those markets, parties often use standardized terms and prefer textualist enforcement, consistent with their model.[105] As an example of higher uncertainty and relatively large-scale markets, GSS point to the M&A market, where the use of open-ended standards such as best efforts provisions and material adverse change clauses abound, and the highly contextual doctrines of Delaware corporate law that police it.[106] Finally, GSS point to markets, such as biotechnology, where advanced technology is developed collaboratively through braided contracting as the example of high uncertainty but low scale.

Based on those exemplary markets, GSS's model of what this article calls "contingent

104. This figure is reproduced from Gilson et al., *Text and Context*, *supra* note 10, at 66.

105. *See, e.g.*, Lisa Bernstein, *Private Commercial Law in the Cotton Industry: Creating Cooperation through Rules, Norms, and Institutions*, 99 MICH. L. REV. 1724, 1727 (2001) (examining the enforcement mechanism employed by "the two most important private commercial law institutions in the domestic cash cotton trade"); Bernstein, *supra* note 20; Bernstein, *supra* note 22.

106. For an example that is purely contractual, and does not rely largely upon company law, we might also look to "honorable engagement" arbitration provisions in reinsurance treaties. The reinsurance market is a substantial market that, at least until the late 20th century, was characterized by a rather informal form of contracting—handshake agreements briefly hammered out on brief "placement slips" that did not pin down obligations with specificity. John J. McDonald Jr., *Reinsurance Arbitration 2001: Will the New Ways Cripple "Arbitration Clause"?*, 68 DEF. COUNS. J. 328, 328 (2001). Those slips would typically include a reference to an industry standard arbitration provision, which empowers the arbitrators to view the agreement as an "honorable engagement" and not a formal contract:

> All arbitrators shall interpret this Contract as an honorable engagement rather than as merely a legal obligation. They are relieved of all judicial formalities and may abstain from following the strict rules of law. They shall make their award with a view to effecting the general purpose of this Contract in a reasonable manner rather than in accordance with a literal interpretation of the language.

Larry Schiffer, *The Honorable Engagement Clause (But I Thought I Had a Legal Contract!)*, INT'L RISK MGMT. INST. (Mar. 2007), https://www.irmi.com/articles/expert-commentary/the-honorable-engagement-clause [https://perma.cc/Q2XL-SUP8]. In short, in the reinsurance market, parties historically have expressly chosen contextualist enforcement, rather than textualism.

market infrastructure" has the ring of truth. What the approach struggles to explain with real specificity, however, is within-market variation. That level of granularity may be unnecessary for the over-arching theory of economic organization that GSS are building. For the courts called upon to enforce these agreements, however, more precision would likely be beneficial.

B. Additional Fault Lines in Contingent Infrastructure

In an insightful working paper, *Contractual Chains*, Joel Watson argues that many contractual relationships experience a type of externality that has been largely overlooked in the economics (and, by implication, legal) literature on contract design.[107] The externality arises when an exchange occurs within a broader network of transactions, which can affect a given deal, but the parties to that contract do not have a contractual relationship with those other members of the network.[108] Watson refers to these externalities as arising from a "lack of direct links," making them "LDL externalities."[109] Watson uses subcontracting as an example to illustrate LDL externalities: An original equipment manufacturer ("OEM") may have a direct contractual relationship with a tier-1, or prime, supplier, who then has contractual relationships with tier-2 suppliers.[110] The OEM may care how those tier-2 suppliers perform, because any mistakes from them will affect the overall project, but the OEM lacks a direct contractual connection to address the externality.[111]

This sub-section unpacks some of the implications LDL externalities may hold for identifying the limits of braiding theory. It first highlights a type of LDL externality, technological spillovers, that are often particularly acute in collaborative innovation. It then raises the possibility that braiding mechanisms respond, in part, to these additional externalities, and not just opportunistic hold-up. Contracts are multivalent, rather than focused on a singular type of risk.[112]

Second, this sub-section then notes that the industry networks shaping LDL externalities typically have uneven distributions of links among their participants. For instance, some members of the network may have many links, and some may have few. This raises the possibility that the intensity of certain LDL externalities differs depending upon a party's location within the industry network.

1. Multidimensional Exchange Hazards[113]

Collaborating with another company in the development of new technology increases

107. Joel Watson, Contractual Chains 1 (2018) (unpublished manuscript) (available at https://econweb.ucsd.edu/~jwatson/PAPERS/Watsonchains.pdf [https://perma.cc/B4PN-7YV3]).

108. *Id.*

109. *Id.*

110. *Id.* at 1–2.

111. Indeed, in some supply chains, such as in the automotive industry, it is not uncommon for OEMs to direct their tier 1 suppliers to source parts from certain tier 2 suppliers in an effort to address this type of externality. *See, e.g.*, DELOITTE, SUB-SUPPLIER MANAGEMENT DIRECTED PARTS IN THE AUTOMOTIVE INDUSTRY 13 (2018), https://www2.deloitte.com/content/dam/Deloitte/de/Documents/consumer-industrial-products/Deloitte_Sub-supplier_Management_Directed_Parts_in_Automotive_Industry.pdf [https://perma.cc/GE7H-U7Y2] (discussing directed buy).

112. Jennejohn, *supra* note 14, at 313.

113. This discussion draws upon Jennejohn, *supra* note 14.

the possibility that one's proprietary technology will spillover to, or otherwise be affected by, third parties. A consistent refrain in the practitioner literature is the importance of intellectual property issues in collaborations.[114] In turn, a growing body of economics scholarship examines how the characteristics of the property regime affect market structure and firm boundaries. The research argues that the ability to profit from an innovation may depend on control of complementary assets, suggesting that firm boundaries could act as important appropriability mechanisms where property rights in foreground intellectual property are uncertain.[115] Scholarship has found that, where property rights are comparatively strong, markets for technology can develop, leading to a finer division of labor between upstream research firms and downstream manufacturers.[116]

In contrast, where intellectual property rights are insufficiently defined, organizational boundaries may play a greater role in addressing appropriability problems. In other words, incompleteness in property rights, just like incompleteness in contracting, can motivate vertical integration decisions.[117] This, in turn, suggests that contracts may be used to address those spillover problems.

Relatedly, collaboration also raises the possibility that coordination costs will increase. Perhaps the most basic challenge collaborative innovation presents is coordinating a joint learning process across two or more organizations. Any productive activity involving more than one actor presents a coordination problem—who is going to do what and when.[118] Where tasks are simple, coordination can be achieved through straightforward communication rules. But where tasks are complex, coordination poses

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114. Review of the practitioner literature indicates that the prospect of intellectual property spillovers often dominates collaborating parties' attention. *See, e.g.*, *Strategic Alliances in Life Sciences: Are You Ready?*, DELOITTE, 5 (Sept. 2014), https://www2.deloitte.com/content/dam/Deloitte/ch/Documents/life-sciences-health-care/ch-en-strategic-alliances-in-life-sciences.pdf [https://perma.cc/Y6TC-4525] ("[B]y combining the knowledge of two or more entities, the imminent danger of safeguarding intellectual property (IP) is a daily occurrence."); Martha B. Steinbock, *How to Draft a Collaborative Research Agreement*, *in* HANDBOOK OF BEST PRACTICES, http://www.iphandbook.org/handbook/chPDFs/ch07/ipHandbook-Ch%2007%2004%20Steinbock%20Collaboration%20Agreements.pdf [https://perma.cc/KQN3-4EXF] (last visited Feb. 10, 2020) ("Perhaps the most important section of the general provisions [of an alliance contract] deals with the intellectual property . . . provisions.").

115. David J. Teece, *Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy*, 15 RES. POL'Y 285, 304 (1986).

116. *See, e.g.*, ASHISH ARORA ET AL., MARKETS FOR TECHNOLOGY: THE ECONOMICS OF INNOVATION AND CORPORATE STRATEGY 115–17 (2001) (arguing that "stronger [intellectual property rights] can enhance the efficiency of technology transfers, and hence encourage the diffusion of technology"); Ashish Arora & Robert P. Merges, *Specialized Supply Firms, Property Rights and Firm Boundaries*, 13 INDUS. & CORP. CHANGE 451, 453–54 (2004); Jonathan M. Barnett, *Intellectual Property as a Law of Organization*, 84 S. CAL. L. REV. 785, 791–92 (2011); Naomi R. Lamoreux & Kenneth L. Sokoloff, *Long-Term Change in the Organization of Inventive Activity*, 93 PROC. NAT'L ACAD. SCI. U.S. 12686, 12686 (1996); Naomi R. Lamoreaux & Kenneth L. Sokoloff, *Location and Technological Change in the American Glass Industry During the Late Nineteenth and Early Twentieth Centuries* 3 (Nat'l Bureau of Econ. Research, Working Paper No. 5938, 1997), available at http://www.nber.org/papers/w5938.pdf [https://perma.cc/3P3D-CAQK].

117. *See* Oren Bar-Gill & Gideon Parchomovsky, *Law and the Boundaries of Technology-Intensive Firms*, 157 U. PA. L. REV. 1649, 1656–57 (2009) (discussing how covenants not to compete affect overall firm efficiency); Robert P. Merges, *Intellectual Property Rights, Input Markets, and the Value of Intangible Assets* 1 (Feb. 9, 1999) (working paper version), https://www.law.berkeley.edu/files/iprights.pdf [https://perma.cc/N3VZ-ULKW].

118. *See* HERBERT H. CLARK, USING LANGUAGE 91 (1996) ("In each joint act, the participants face a coordination problem: What participatory actions do they expect each other to take? To solve this problem, they need a coordination device—something to tell them which actions are expected.").

significant information costs on actors.[119] Because of cognitive limits, actors engaged in a complex task cannot fully process or anticipate one another's interactions, and the prospect for coordination failure—in the form of omissions, duplication, or lack of interoperability—arises. Failure to synchronize the interactions of a production team can lead to entropy.

Coordination problems between collaborators can be profound in at least two senses. First, firms collaborating in order to access knowledge that they cannot efficiently develop internally must confront a learning curve when working with a party that does have that expertise.[120] Surmounting that learning curve often requires increasing the contact points between collaborating firms, as they combine teams and share information, and those interconnections can lead to entropy if not contained within routines for progressing through the joint learning process.[121] Second, firms must also coordinate among the multiple collaborations they simultaneously have underway. That is, they must ensure that developments in one project complement progress in adjacent areas. As we saw in the example of the Boeing 787, in modern aerospace engineering, where multiple suppliers often develop sub-systems in tandem, "concurrency risk"—or the risk that suppliers will get out of step in the co-development process—can be a concern.[122] This means that they must add a further layer of complexity, in effect replicating bilateral coordination across multiple partnerships.

Such entropy problems can be an impetus for vertical integration. If knowledge is tacit and therefore difficult to transfer, then integrating production into a single organization can improve information flows between team members.[123] Firms may integrate to economize on production costs, not only transaction costs.[124]

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119. *See* HERBERT A. SIMON, ADMINISTRATIVE BEHAVIOR: A STUDY OF DECISION-MAKING PROCESSES IN ADMINISTRATIVE ORGANIZATIONS 93–97 (4th ed. 1997).

120. *See* Stefano Brusoni et al., *Knowledge Specialization, Organizational Coupling, and the Boundaries of the Firm: Why Do Firms Know More than They Make?*, 46 ADMIN. SCI. Q. 597, 597–98 (2001) (arguing that some internal expertise is required in order to effectively collaborate).

121. Ranjay Gulati & Harbir Singh, *The Architecture of Cooperation: Managing Coordination Costs and Appropriation Concerns in Strategic Alliances*, 43 ADMIN. SCI. Q. 781, 784 ("Concerns about anticipated coordination costs are particularly salient in strategic alliances, which can entail significant coordination of activities between the partners . . . . [Those costs] arise[] from the complexity of ongoing coordination of activities to be completed jointly or individually across organizational boundaries and the difficulties associated with decomposing tasks and specifying a precise division of labor across partners in the alliance . . . ."); *see generally* Gaurav Laroia & Shiv Krishnan, *Managing Drug Discovery Alliances for Success*, 48 RES. TECH. MGMT. 42 (recommending that alliance design respond to task complexity).

122. *See Joint Strike Fighter: Restructuring Added Resources and Reduced Risk, but Concurrency Is Still a Major Concern: Testimony Before the Subcomm. on Tactical Air and Land Forces of the H. Comm. on Armed Services*, 112th Cong. (2012) (statement of Michael J. Sullivan, Director, Acquisition and Sourcing Management); *see also* Matthew C. Jennejohn, *Contract Adjudication in a Collaborative Economy*, 5 VA. L. & BUS. REV. 173, 184–85, 190–94 (2010) (illustrating decentralization in the context of the production of the Boeing 787). Coordination problems are not isolated to massive engineering projects. *See, e.g.*, Alan M. Wing et al., *Optimal Feedback Correction in String Quartet Synchronization*, 11 J. ROYAL SOC'Y INTERFACE 1, 1 (2014) (discussing hierarchical and emergent coordination strategies in string quartets).

123. *See* Harold Demsetz, *The Theory of the Firm Revisited*, 4 J.L. ECON. & ORG. 141, 157–61 (1988) (discussing the economy of knowledge within industries and between firms).

124. *See, e.g.*, RICHARD N. LANGLOIS & PAUL L. ROBERTSON, FIRMS, MARKETS AND ECONOMIC CHANGE: A DYNAMIC THEORY OF BUSINESS INSTITUTIONS 2–4 (1995) (proposing an evolutionary model to attempt to show when a corporate organization should undertake innovations); Nicholas Argyres, *Evidence on the Role of Firm Capabilities in Vertical Integration Decisions*, 17 STRATEGIC MGMT. J. 129, 130 (1996) (presenting

Including spillover and entropy concerns in our theory of economic organization introduces an intriguing possibility: Rather than just responding to hold-up threats, collaborators may design their agreements to address an array of innovation problems. In other words, both sides of the theoretical equation—how exchange hazards are understood and how governance tools are fashioned—can be pluralistic. The result is a highly complex decision landscape. Parties not only have to navigate more than one type of transaction cost, they must also choose how to combine different types of governance tools into a coherent portfolio—the multivalent contract.

Multidimensionality raises two important possibilities. First, it expands our understanding of the ends a governance mechanism can serve. Consider, for example, how the management committees at the core of GSS's braiding theory might serve purposes other than addressing opportunistic hold-up. Perhaps the most obvious explanation for consensus-based committees is that they give parties veto rights over the trajectory of the collaboration, not that they foster informal constraints.[125] As Gordon Smith notes, consensual decision-making allows parties to put the brakes on a joint discovery process without breaching the terms of the deal.[126] A multidimensional perspective illuminates why those rights may be so important. Consensus-based committees give a party a veto right at three points in the collaborative relationship where spillover issues arise.[127]

First, in the collaboration's early stages, a unanimity requirement gives a party a chance to steer the collaboration in a direction that avoids outcomes that may, for example, conflict with adjacent areas of that party's patent portfolio or with other collaborations that it might have underway. In that way, the party can "design away" from fraught areas, and target "white space" in the patent landscape where some freedom of movement is available. Potential externalities are nipped in the bud, as it were. Delineation of discrete project boundaries is consistent with this reading—the committee is a tool for policing those boundaries and ensuring that the collaboration does not experience mission drift that interferes with adjacent projects.

Second, the unanimity requirement gives a party a veto over definitional decisions relating to the boundaries of intellectual property.[128] The committee is a forum for

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evidence that capabilities considerations affect vertical integration decisions); Bruce Kogut & Udo Zander, *Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology*, 3 ORG. SCI. 383, 384 (1992) (outlining the economy of knowledge in technology transfers); Kirk Monteverde, *Technical Dialog as an Incentive for Vertical Integration in the Semiconductor Industry*, 41 MGMT. SCI. 1624, 1624–25 (1995) (describing and explaining a trend of semiconductor companies seeking to reduce production costs by subcontracting out their physical manufacturing).

125. *See generally* D. Gordon Smith, *The Exit Structure of Strategic Alliances*, 2005 ILL. L. REV. 303 (2005).

126. *Id.* at 316.

127. These committees can also remain in operation after the collaboration terminates, emphasizing the importance of concerns over ex post appropriability rather than ex ante investment. *See, e.g.*, Genelabs Techs., Inc. & Gilead Scis., Inc., License and Research Collaboration Agreement § 7.2 (Sept. 29, 2004) (on file with the author) (establishing a stand-alone patent committee, which operated according to unanimity rules, that was to continue operating after the end of the research program term).

128. Escalation procedures complement consensual decision-making's veto role in addressing appropriability concerns. Escalation may address appropriability problems because they enlist more senior executives with an increasingly panoramic view of the patent landscape, a comprehensive understanding of the firm's background IP and R&D pipelines, and a fuller understanding of all the company's strategic interests into the dispute resolution process. *See* Stephen I. Glover & Alisa Babitz, *Drafting the Joint Venture Agreement*, *in* PARTNERSHIPS, JOINT VENTURES & STRATEGIC ALLIANCES §§ 6, 6.16[4][a] (2020) ("The venturers' executive officers may have a broader perspective than the individuals who are involved with the venture's problems on a

negotiating the relationship between background IP and foreground IP and for drawing dividing lines based on those relationships.[129] Each party has a tool for protecting its interest when decisions are being made as to whether an invention falls within one party's exclusive ownership or whether it will be owned jointly. Relatedly, the unanimity requirement allows a party to prevent its counterparty from making decisions with respect to patent prosecution or enforcement that might affect those boundary decisions or other aspects of a party's background IP.[130]

Finally, where foreground IP is jointly owned, the veto is a means for controlling spillovers that could result from the choices of the other co-owner. Because U.S. patent law allows a joint owner to license and otherwise exploit a jointly owned asset without requiring approval of or accounting to the other owner(s), a party could find itself in a situation where, for example, its collaborator is licensing foreground IP to one of the party's competitors. Contract provisions requiring collective decision-making on licensing jointly owned foreground IP to third parties allows a party to address such situations,[131] and the veto right approximates through contractual means the right to exclude that arises from sole ownership.

Governance committees may also be part of a modularity strategy. Where interactions between parties are thick, collaborators delegate management of those issues to a committee bound by a unanimity rule, which creates partial separation between the committee and the constituent firms, thereby compartmentalizing the decision environment. That separation allows the committee representatives to specialize in managing the discovery process. On the flip side, delegating management to a dedicated committee allows the parent firms to focus on systemic coordination issues while the committee focuses on coordination issues at the bilateral level. As the task environment's complexity increases, there is greater separation of and devolution to sub-committees. Finally, a modularity strategy allows disputes to be cabined, preserving executives' time, and preventing dispute resolution in the context of a continuing relationship from transforming into litigation.

To illustrate, Figure 4 below outlines the governance committee structure and dispute resolution system established in a recent alliance contract between Janssen and Pharmacyclics.[132] The structure of the system reflects the modulated logic discussed above. Committees are dedicated to specific types of exchange hazards. Issues that cannot be

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day-to-day basis, and thus may be able to break the impasse."). Escalation may be about gaining perspective on one's asset portfolio and its valuation as much as it is about fostering information flows.

129. Note that the coordination issues discussed above extend to the intellectual property context, where parties must cooperate with respect to patent filings, etc. *See* Stephen C. Costalas & Thomas A. Rayski, *Negotiating Pharma Collaboration Agreements: Common and Critical Issues*, 5 LIFE SCI. L. & INDUS. REP. 525, 526–27 (2011) (discussing the complex, intellectual property rights that stem from collaboration agreements).

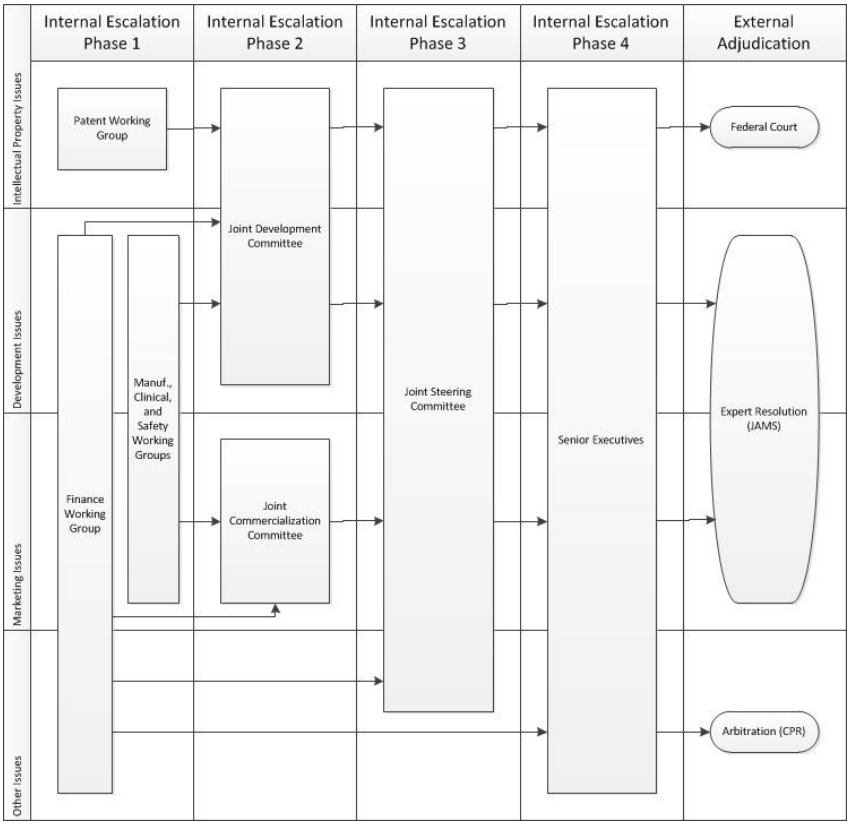
130. *See, e.g.*, *id.* at 527 ("[An] intellectual property owner may be reluctant to cede control of enforcement of pre-existing intellectual property to a collaborator because of the risk that the validity of the intellectual property may be challenged by the defendant in an enforcement action.").

131. *See* MARTIN A. BADER, INTELLECTUAL PROPERTY MANAGEMENT IN R&D COLLABORATION 16 (Müller & Bihn eds., 2006) (finding that joint ownership of foreground IP causes "increased administrative efforts before and after the collaboration").

132. *Pharmacyclics, Inc. & Janssen Biotech Inc., Collaboration and License Agreement*, SEC.GOV (Dec. 8, 2011),
https://www.sec.gov/Archives/edgar/data/949699/000092189512000285/ex101to10q07380_02082012.htm [https://perma.cc/7V5D-RXY3].

resolved at the lower levels are escalated to more centralized committees. However, dispute resolution is trifurcated between two forms of private dispute resolution and federal court, depending upon the nature of the dispute.

Figure 4: Process Diagram of the Janssen/Pharmacyclics Committee and Dispute Resolution System



Recognizing the contingent relationships between governance devices is powerful because it provides a framework for understanding at a detailed level the diversity of design strategies we observe in practice. If only hold-up problems motivate contract design, then, as we saw in Part II.C above, differences in governance strategy are befuddling unless there is reason to believe that the intensity of hold-up threats differs materially between collaborations. By acknowledging the potential for trade-offs between governance tools, the notion of multiple exchange hazards gives us a framework for understanding why one collaboration may employ different mechanisms than another collaboration. Variations between the intensity of exchange hazards collectively affecting one collaborative relationship and the next leads to different governance trade-offs for different collaborations.

2. Differing Network Topology

A second possibility is that the structure of an industry network will affect the

intensity of LDL externalities. The basic constituent parts of any network are its vertices or nodes, which here are the companies entering into contracts with one another, and the edges or ties, which represent the contractual relationships between the firms. Once those nodes and ties 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.[133] With those networks assembled, we can then run some simple analytics to understand their structure. For instance, we can analyze the network and subsidiary ego networks to determine the extent to which they are transitive: a fully transitive or "complete" network is one in which every node is connected to the other nodes in the network.[134] We can also 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.[135]

Network structure matters because, in most social networks, links between nodes are not evenly distributed. Some nodes have many links, and some have few. Consider the structure of the global biotechnology network. The global network of collaborative relationships in biotech from 1995-2015 contains over 32,000 contracts, involving over 15,000 parties.[136] At first, the sheer size of the network suggests a thick web of interconnections between companies. On closer look, however, the story is more nuanced. Some companies, which are found at the center of the network, have many connections with other companies. For instance, the most connected company, Pfizer, Inc., has 2630 links to other companies in the network.[137] Most companies, however, have far fewer connections—the majority only have one or two links to other firms.[138]

Having more connections—or becoming more "embedded"—within a network exacerbates those spillover risks. Sociological research has long recognized that network embeddedness has a downside, with origins in Granovetter's classic article on socially-embedded exchange.[139] Uzzi's subsequent work built upon that foundation, introducing the idea that networks introduce a "paradox of embeddedness."[140] Analyzing contracting practices in 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; however, Uzzi also finds that buyers that had socially embedded ties, rather than arm's-length deals, with their suppliers, who had many of the same relationships, performed poorly compared to participants with a mix of embedded and arm's-length contractual arrangements.[141] Uzzi argues that being densely embedded in a network with many redundant ties reduces the

133. MATTHEW O. JACKSON, SOCIAL AND ECONOMIC NETWORKS 28 (2010).

134. *Id*. at 27–28.

135. *Id*. at 29.

136. Data on biotechnology alliance relationships were collected primarily from Cortellis's proprietary database.

136. *Id.*

138. *Id.*

139. Mark Granovetter, *Economic Action and Social Structure: The Problem of Embeddedness*, 91 AM. J. SOC. 481 (1985) (noting that networks can circulate not only accurate information useful for policing opportunism but also inaccurate information that undermines informal sanctions).

140. *See generally* Brian Uzzi, *Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness*, 42 ADMIN. SCI. Q. 35 (1997); Brian Uzzi, *The Sources and Consequences of Embeddedness for the Economic Performance of Organizations: The Network Effect*, 61 AM. SOC. REV. 674 (1996).

141. *Id*.

flow of novel information, because few of the market players have unique connections.[142] Information becomes ossified, and collaborations fail due to a "paucity of competence" instead of a surfeit of opportunism.[143]

Quantitative research studying the biotechnology network finds a high level of dynamism, suggesting that companies are aware, at least implicitly, of the paradox of embeddedness and therefore actively seek out diverse collections of partners.[144] That pursuit of diversity may bring benefits, as new innovative possibilities come into focus as parties combine erstwhile disparate technologies, but they also require parties to invest in the capacity to work with a wide array of partners. Collaborating with multiple, diverse partners also heightens the likelihood of technology spillovers. For a simple demonstration of the problem, consider Figure 5 below, which shows the results of a simulation model that compares how quickly information diffuses from a central company and from a peripheral company in the network of the tens of thousands of contractual relationships among biotechnology and pharmaceutical companies.[145] The simulation demonstrates that a new technology originating in the center of the network diffuses far more rapidly than an innovation from the periphery—diffusion from the central origin achieves full propagation in approximately 20 time periods compared to the peripheral origin, which takes over 40 time periods.[146] The thick connections at the core of the network transfer information throughout the entire network very efficiently.

142. Uzzi, *supra* note 140, at 35–37.

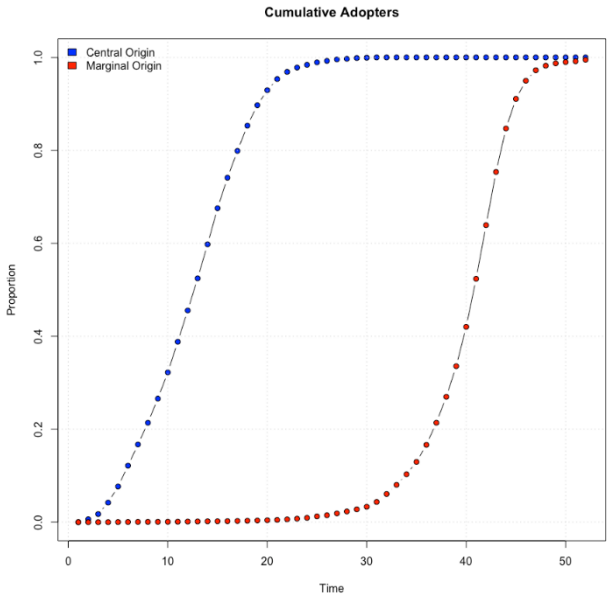
143. Andrew Schrank & Josh Whitford, *The Anatomy of Network Failure*, 29 SOC. THEORY 151–77 (2011).

144. For an excellent study that analyzes dynamics in a network of biotechnology alliances, see Walter W. Powell et al., *Network Dynamics and Field Evolution: The Growth of Interorganizational Collaboration in the Life Sciences*, 110 AM. J. SOC. 1132 (2005).

145. The diffusion simulation was modeled using the netdiffuseR package in R. A scale free network with the same number of nodes as the Biotech Alliance Network was generated, and then diffusion was simulated over 52 time periods with nodes' threshold for adoption randomly assigned, and with a limited amount of rewiring of links between nodes from one time period to the next to roughly reflect the dynamic nature of the network. The simulation model suggests what spillovers might be like where there are no legal limitations to the transfer of the technology.

146. This is consistent with empirical findings in the literature on diffusion in networks. *See* Matthew O. Jackson, *Networks and Economic Behavior*, 1 ANN. REV. ECON. 489, 504 (2009) ("Very highly connected nodes are more susceptible to infection, . . . all else constant, than less connected nodes because they have more interactions and are more likely to meet infected nodes. This leads networks with fatter-tailed degree distributions to be more susceptible to the initial spreading of disease.").

Figure 5: Stimulated Diffusion of Technology from Central and Peripheral Origins in a Core/Periphery Network



That swift diffusion of information from the core of a network illustrates how spillover concerns can become acute. Collaborating with a company centrally positioned in the network increases the likelihood that technical information will leak out. This is particularly problematic if one's current partner can later collaborate with one's competitors. As Powell et al. note, "[t]he pattern of cross-cutting collaborations [in biotech] often results in a partner on one project being a rival on another."[147] The takeaway here is that contract design decisions may turn, in part, on parties' positions within an industry network, due to how that network affects LDL externalities such as technology spillovers.

V. CONCLUSION

This essay has reviewed the current state of the art in relational contracting theory, with a particular focus upon GSS's braiding thesis. It has provided new empirical evidence from modern U.S. defense contracting, which suggests that braiding provides an accurate explanation of how preliminary agreements are used in the negotiation of complex agreements. The paper has then turned to next steps in the literature and has focused upon clearly identifying the limits of braided agreements. Building upon GSS's market-based theory of non-unitary contract law, the paper suggests two avenues for constructing a more fine-grained theory of contingent market infrastructure: An expanded menu of exchange hazards that affect contract design and how network structure may affect the intensity of those hazards. Additional possibilities surely exist, and the overall theme of the paper is an abiding optimism in the ability of the next generation of relational contracting scholarship

147. Powell et al., *supra* note 144, at 1187.

to uncover them.