Do Networks Govern Contracts?

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An influential literature in private law argues that the legal system interferes with modern markets' "private ordering." Private ordering refers to parties relying upon informal institutions, like social norms and reputational sanctions, to enforce legal obligations. This informal governance is made possible by thick networks of social or commercial relationships, which circulate information about parties' behavior. Social networks, not the state, govern commerce.

This Article argues that the private ordering literature has overlooked a paradox at the heart of its theory. The same networks that circulate reputational information also provide conduits for valuable technical information to leak from one company to another. In many 21st century markets, where innovation is crucial for a company's survival, those technological spillovers are highly salient. The trading network becomes a cost, not just a benefit.

This Article provides new empirical evidence that parties in highly innovative markets actually rely heavily on the formal legal system to address the risks that networks create. It shows that parties increasingly use formal contracts as they become more connected in a market, just the opposite of what private ordering theory predicts.

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* Professor of Law, BYU Law School. Many thanks to Curt Anderson, Ian Ayres, Clark Asay, Jonathan Barnett, Bobby Bartlett, Lisa Bernstein, Brad Bernthal, Sadie Blanchard, Iva Bozovic, Fabrizio Cafaggi, Tony Casey, Albert Choi, Jorge Contreras, Doug Cumming, Steven Davidoff Solomon, Robert Ellickson, Elizabeth Emens, Gina-Gail Fletcher, Elisabeth de Fontenay, Mira Ganor, George Geis, Bob Gibbons, Clayton Gillette, Vic Goldberg, Zohar Goshen, Mike Guttentag, Gillian Hadfield, Michael Helfand, Dan Hemel, Bert Huang, Christine Hurt, Cathy Hwang, Kate Judge, Daniel Klerman, Jody Kraus, Sofia Johan, Christine Jolls, Alex Lee, Zach Lisgow, Kyle Mayer, Tom Merrill, Dave Moore, John Morley, Ed Morrison, Julian Nyarko, Oren Perez, Kish Parella, Elizabeth Pollman, Alex Raskalnikov, Ed Rock, Roberta Romano, Chuck Sabel, Bob Scott, Elizabeth Scott, Megan Shaner, Gladriel Shobe, Jarrod Shobe, Gordon Smith, Danny Sokol, Paul Stancil, George Triantis, Dan Wasserburg, Joel Watson, Bill Whitford, Josh Whitford, Todd Zenger, and participants at presentations at Columbia Law School, the 2019 Conference on Empirical Legal Studies, the Yale Law, Economics & Organization Workshop, the Private Law and Network Governance Workshop at Bar Ilan University, the Fourth Workshop on Relational Contracts at the Univ. of Chicago, the Conference on Empirical Legal Studies in Europe, NYU Law School's Law & Economics Workshop, the BYU Winter Deals Conference, the University of Utah's Law and Biomedicine Colloquium, Yale Law School's Workshop on Formal and Informal Governance, UC-Boulder's Junior Business Law Conference, USC's Center for Law and Social Science for helpful comments. The author also thanks a number of practitioners, who requested anonymity to speak candidly, for their participation in this project's qualitative empirical study. Brandon Anderson, Travis Arnold, Jillaine Chaston, Tye Christensen, Marcus Gamboa, Nic Jeter, Tyler King, Meg Krivanec, Natalie Lambert, Paul Mann, Mariah Moody, Ashley Moulder, Crystal Powell, Hunter Reynolds, Cami Schiel, Samantha Scott, Daniel Shen, Hayden Smith, Dallin Sopp, and Chad West provided excellent research assistance. Special thanks to Shawn Nevers and Annalee Hickman for exceptional library support. All errors are the author's. The generous support of a BYU internal research grant is also acknowledged.

Innovative companies "creatively order" the development of new technology with formal law, not with old-fashioned informal sanctions. Creative ordering recaptures a role for the state in modern markets, leading to important normative implications in two settings. The first is contract law, where creative ordering provides a new basis for rejecting calls for minimalistic contract enforcement. It also elevates the social benefits of spillovers as a key normative value at the heart of contract enforcement, rather than a peripheral issue specific to, for instance, employment contracting. The second setting is industrial policy, where creative ordering provides the administrative state with a new tool to promote economic development. In fact, creative ordering is already playing this role, as the U.S. federal government's and European Union's strategy of contracting for Covid-19 vaccine innovation illustrates.

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I. INTRODUCTION

A venerable line of scholarship, spanning both economics and law, argues that informal institutions, rather than the formal legal system, often enforce contractual obligations.[1] Economic exchange is "privately ordered" without reliance on state institutions.[2] Indeed, formal legal institutions may interfere with private ordering.[3]

Numerous studies of early modern commercial activity identify evidence of private ordering, placing contemporary capitalism's roots in a stateless past.[4] The story of a 16th century trader provides an example of the type. In 1585, the young Dutch merchant Hans Thijs had a contracting problem. Stationed in Danzig at the time, Thijs was trading local leather goods to the Netherlands.[5] The problem was ensuring that he was not cheated of a fair price when his goods were sold in far-away Amsterdam.[6] So Thijs, like many Hanseatic

1. This literature traces its modern origins to Macauley's classic study on informal contracting in mid-20th century commercial relationships. Stewart Macauley, *Non-Contractual Relations in Business: A Preliminary Study*, 28 AM. SOC. REV. 55 (1963).

2. "Private ordering" is a concept that has been used so widely that its precise meaning often turns on the specific context in which it is applied. Here, private ordering is understood as a combination of privately supplied rules and private enforcement of those rules, as described in the classic studies on the topic. *See, e.g.*, ROBERT C. ELLICKSON, ORDER WITHOUT LAW: HOW NEIGHBORS SETTLE DISPUTES (1991); JANET TAI LANDA, ECONOMIC SUCCESS OF CHINESE MERCHANTS IN SOUTHEAST ASIA: IDENTITY, ETHNIC COOPERATION AND CONFLICT (2016); Lisa Bernstein, *Opting Out of the Legal System: Extralegal Contractual Relations in the Diamond Industry*, 21 J. LEGAL STUD. 115 (1992); Barak D. Richman, *How Community Institutions Create Economic Advantage: Jewish Diamond Merchants in New York*, 31 L. & SOC. INQUIRY 383 (2006); BARAK D. RICHMAN, STATELESS COMMERCE: THE DIAMOND NETWORK AND THE PERSISTENCE OF RELATIONAL EXCHANGE (2017).

3. *See*, *e.g.*, Ernst Fehr & Simon Gächter, Do Incentive Contracts Crowd Out Voluntary Cooperation? (Nov. 5, 2001) (unpublished manuscript), https://papers.ssrn.com/abstract=289680 [https://perma.cc/BYA5-JEMT]; Peter H. Huang & Ho-Mou Wu, *More Order Without More Law: A Theory of Social Norms and Organizational Cultures*, 10 J.L. ECON. & ORG. 390 (1994); ELLICKSON, *supra* note 2; Lisa Bernstein, *The Questionable Empirical Basis of Article 2's Incorporation Strategy: A Preliminary Study*, 66 U. CHI. L. REV. 710 (1999).

4. The use of privately ordered enforcement institutions, rather than public law and courts, has been a popular explanation for how economic development occurs in early commercial societies. *See, e.g.*, Joel Mokyr, *The Institutional Origins of the Industrial Revolution*, in INSTITUTIONS AND ECONOMIC PERFORMANCE 64, 72–73 (Elhanan Helpman ed., 2008) (noting that commercial disputes rarely went to court but instead were usually arbitrated in early industrial England); Kevin E. Davis & Michael J. Trebilcock, *The Relationship Between Law and Development: Optimists versus Skeptics*, 56 AM. J. COMPAR. L. 895, 932–38 (2008) (summarizing the literature claiming that "law does not matter" for economic development); John McMillan & Christopher Woodruff, *The Central Role of Entrepreneurs in Transition Economies*, 16 J. ECON. PERSPS. 153 (2002); John McMillan & Christopher Woodruff, *Private Order Under Dysfunctional Public Order*, 98 MICH. L. REV. 2421 (2000); John McMillan & Christopher Woodruff, *Dispute Prevention Without Courts in Vietnam*, 15 J.L. ECON. & ORG. 637 (1999); Karen Clay, *Trade Without Law: Private—Order Institutions in Mexican California*, 13 J.L. ECON. & ORG. 202 (1997); Avner Greif, *Contract Enforceability and Economic Institutions in Early Trade: The Maghribi Traders' Coalition*, 83 AM. ECON. REV. 525 (1993); Paul R. Milgrom, Douglass C. North & Barry R. Weingast, *The Role of Institutions in the Revival of Trade: The Law Merchant, Private Judges, and the Champagne Fairs*, 2 ECON. & POLS. 1 (1990).

Aspects of this historical literature have been subject to compelling challenges from a number of scholars. *See*, *e.g.*, Emily Kadens, *The Medieval Law Merchant: The Tyranny of a Construct*, 7 J. LEGAL ANALYSIS 251 (2015); Emily Kadens, *The Myth of the Customary Law Merchant*, 90 TEX. L. REV. 1153 (2011–2012); J. H. Baker, *The Law Merchant and the Common Law Before 1700*, 38 CAMBRIDGE L.J. 295 (1979).

5. Oscar Gelderblom, *The Governance of Early Modern Trade: The Case of Hans Thijs, 1556–1611*, 4 ENTER. & SOC'Y 606, 611 (2003).

6. *Id.* at 611–12.

merchants, turned to what he knew best: his personal relationships.[7] By dealing primarily with his relatives, he leveraged the power of informal sanctions to govern his trades. If a relative cheated Thijs on a transaction, Thijs could retaliate by disparaging their reputation within the broader family. Thijs' network of social relationships governed his deals.[8] He relied on this governance system as he expanded his trading business to selling jewels to Paris, Avignon, and Constantinople and later sourcing wine and cloth from Spain.[9] He was not unique. Social networks enforced contractual obligations throughout the Hanseatic League.[10]

Private ordering is not only a matter of historical memory. Recent scholarship argues that private ordering provides the backbone for the thriving clusters of innovative companies that power modern capitalism.[11] The privately ordered enforcement institutions that a merchant like Thijs relied upon are also used in the large, dynamic markets of the 21st century economy, from Silicon Valley[12] to biopharmaceuticals[13] to automotive

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7. *Id.* at 617.

8. *Id.* at 607 ("Kinship, shared cultural beliefs, or the prospect of repeat transactions generated trust among merchants and induced them to respect the agreed-on terms of payment and delivery."). It is important to note, however, that Gelderblom finds evidence of Thijs relying on both informal sanctions and formal legal institutions. *Id.* While the roles of formal legal institutions highlighted in this Article are different than the part they played in Thijs' story, the theory and evidence presented here are consistent with the general thrust of Gelderblom's argument.

9. *Id*. at 620–22.

10. *See generally* ULF CHRISTIAN EWERT & STEPHAN SELZER, INSTITUTIONS OF HANSEATIC TRADE: STUDIES ON THE POLITICAL ECONOMY OF A MEDIEVAL NETWORK ORGANIZATION (2016) (applying the network organization concept to the Hanseatic League, a medieval network of German towns and trading partners). The Hanseatic experience is similar to other trading networks. *See*, *e.g.*, AVNER GREIF, INSTITUTIONS AND THE PATH TO THE MODERN ECONOMY: LESSONS FROM MEDIEVAL TRADE (2006); LANDA, *supra* note 2; Janet T. Landa, *A Theory of the Ethnically Homogeneous Middleman Group: An Institutional Alternative to Contract Law*, 10 J. LEGAL STUD. 349 (1981); Lisa Bernstein, *Contract Governance in Small World Networks: The Case of the Maghribi Traders*, 113 NW. U. L. REV. 1009 (2019); DIASPORA ENTREPRENURIAL NETWORKS: FOUR CENTURIES OF HISTORY (Ina Baghdiantz McCabe et al. eds., 2005). Braudel's magisterial history of early capitalism suggests similar networks in a variety of markets around the globe. *See generally* FERNAND BRAUDEL, CIVILIZATION AND CAPITALISM, 15TH–18TH CENTURY, VOL. II (2d ed. 1992).

11. The network as a locus of innovation is a persistent theme in economic sociology. *See* HARRISON C. WHITE, MARKETS FROM NETWORKS: SOCIOECONOMIC MODELS OF PRODUCTION 1 (2002) ("An increasing number of markets are something more than sites for direct transactions between buyers and sellers. These markets are mobilizers of production in networks of continuing flows . . . . [These networks] induce and adapt flows in production and service . . . ."); Walter W. Powell, Kenneth W. Koput & Laurel Smith-Doerr, *Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology*, 41 ADMIN. SCI. Q. 116 (1996) (analyzing networked innovation in the biotechnology industry).

The importance of networks is an old idea, however, with roots in Marshall's discussion of industrial districts over 100 years ago. *See*, *e.g.*, ALFRED MARSHALL, PRINCIPLES OF ECONOMICS 268 (8th ed. 1920). For the leading analysis of the public policy issues arising from networked production, see YOCHAI BENKLER, THE WEALTH OF NETWORKS: HOW SOCIAL PRODUCTION TRANSFORMS MARKETS AND FREEDOM (2006).

12. *See* Ronald J. Gilson, *Engineering a Venture Capital Market: Lessons from the American Experience*, 55 STAN. L. REV. 1067 (2003) (analyzing the idiosyncratic U.S. venture capital market from post-Gold Rush California to the gleaming suburban office parks of Silicon Valley).

13. *See generally* David T. Robinson & Toby E. Stuart, *Financial Contracting in Biotech Strategic Alliances*, 50 J.L. & ECON. 559 (2007); David T. Robinson & Toby E. Stuart, *Network Effects in the Governance of Strategic Alliances*, 23 J. L. ECON. & ORG. 242 (2007). The term "biopharmaceuticals" is used throughout this Article to refer to the modern medicines industry, which includes traditional pharmaceuticals and biological drugs developed through biotechnology.

manufacturing.[14] Networks of relationships exist in the modern economy, circulating reputational information just like they did for the 16th century Hansa.[15] Informal sanctions run our entire economic system, from vernacular to advanced capitalism.

This Article contests the private ordering claim as it is applied to modern markets.[16] It does not deny that social norms and informal sanctions matter in some 21st century markets—modern commerce is not entirely bereft of trust. Rather, this Article argues that private ordering scholarship has overlooked an important paradox at the heart of its theory of informal enforcement. Modern exchange networks also often pose a cost to transacting parties that prior scholarship has not recognized: the same social network that circulates reputational information throughout a market also allows valuable technical information to leak, or "spill over," to third parties, perhaps even competitors.[17] That spillover risk grows as a party's connections within an exchange network increase. Networks are a double-edged sword.

Spillovers are most salient in innovative markets where new intangible technology is being developed. Consider the following example, which comes from the 21st century biopharmaceutical industry rather than the 16th century leather trading business. In 2003, a small biotechnology company named iBio landed its first big collaboration with a major pharmaceutical partner, Fraunhofer, a large German research organization.[18] For ten years, iBio and Fraunhofer collaborated on the development of new vaccines, sharing their proprietary information with one another to achieve new discoveries.

iBio and Fraunhofer also entered into additional contractual relationships.[19] As they did so, iBio and Fraunhofer's network of relationships grew. In the end, that network

14. *See* Jeffrey Dyer & Kentaro Nobeoka, Creating and Managing a High Performance Knowledge-Sharing Network: The Toyota Case (Mar. 9, 1998) (unpublished manuscript), http://dspace.mit.edu/handle/1721.1/1441 [https://perma.cc/8NXY-GXT4] (describing the process by which Toyota's production network facilitates interorganizational knowledge transfers).

15. *See* Lisa Bernstein, *Beyond Relational Contracts: Social Capital and Network Governance in Procurement Contracts*, 7 J. LEGAL ANALYSIS 561, 604 (2015) [hereinafter Bernstein, *Beyond Rational Contracts*] (noting that "the existence of the network serves to increase the reputational harm and non-legal sanctions for misbehavior").

16. *See, e.g.*, Ronald J. Gilson, Charles Sabel & Robert E. Scott, *Braiding: The Interaction of Formal and Informal Contracting in Theory, Practice, and Doctrine*, 110 COLUM. L. REV. 1377 (2010) [hereinafter *Braiding*]; Ronald J. Gilson, Charles Sabel & Robert E. Scott, *Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration*, 109 COLUM. L. REV. 431 (2009) [hererinafter *Contracting for Innovation*]. That work is directly addressed in my prior scholarship. *See* Matthew Jennejohn, *The Private Order of Innovation Networks*, 68 STAN. L. REV. 281 (2016); Matthew Jennejohn, *Braided Agreements and New Frontiers for Relational Contract Theory*, 45 J. CORP. L. 885 (2020) [hereinafter *Braided Agreements*]. It is important to note that this Article focuses squarely on private ordering scholarship and does not directly engage with Gilson, Sabel & Scott's important adjacent work on the role of "braided agreements" in high technology industries. An important step for future research is to tie these strands of literature together.

17. *See* Brett M. Frischmann & Mark A. Lemley, *Spillovers*, 107 COLUM. L. REV. 257, 259–60 (2007) (discussing the benefits, social importance, geographic, and temporal factors of spillovers).

18. iBio, Inc. v. Fraunhofer USA, Inc., No. 10256-VCMR, 2016 WL 4059257, at *1 (Del. Ch. July 29, 2016). *See also Implications of Court Decision in Favor of iBio, Inc. against Fraunhofer*, BIOSPACE (Aug. 17, 2016), https://www.biospace.com/article/releases/implications-of-court-decision-in-favor-of-ibio-inc-against-b-fraunhofer-b-/ [https://perma.cc/G8W2-V2FX].

19. For instance, iBio and Fraunhofer entered into a development agreement with GE Healthcare. *iBio and Fraunhofer Execute Business Development and Marketing Agreement with GE Healthcare*, FIERCE PHARMA (Sept. 2, 2010, 9:31 AM), https://www.fiercepharma.com/pharma/ibio-and-fraunhofer-execute-business-development-and-marketing-agreement-ge-healthcare [https://perma.cc/8SRU-VPFY].

proved particularly costly to iBio. Acting alone, Fraunhofer entered into agreements for related research with other companies, eventually using technology it had jointly developed with iBio in a different collaboration with one of iBio's competitors.[20] Valuable technology that iBio helped develop and saw as essential to its survival spilled over to a rival. A startup's worst nightmare had come true.

This Article shows how companies like iBio use formal contracts to address the spillover risks that networks create. Companies do not rely upon informal sanctions in these markets. For instance, iBio did not turn to the court of public opinion to discipline Fraunhofer. Rather, iBio sued in Delaware state court to claw back its technology, arguing that Fraunhofer had breached the licensing terms of the parties' formal collaboration agreement.[21]

The Article presents empirical evidence that iBio's reliance on the formal legal system reflects broader trends in the modern economy. A challenge an empirical analysis such as this faces is the sheer size and complexity of the subject of study—technological, organizational, and contractual complexity has grown enormously since Hans Thijs traded commodities across Europe.[22] To provide as comprehensive a picture as possible, this Article combines both qualitative and quantitative methods of analysis to study contemporary contracting behavior.[23] The setting of the study is the biopharmaceutical industry, a market where rich data on contracting behavior is publicly available. Over fifteen years of biopharmaceutical R&D alliances—exceeding over 30,000 contracts—are analyzed. Semi-structured interviews with industry insiders, such as law firm partners, general counsel, management consultants, and alliance managers, were also conducted. Both quantitative and qualitative approaches provide evidence that companies use unique formal contracts to address spillover risks. The governance of biopharmaceutical innovation is deeply legal.

This Article refers to this use of formal contracting to address the spillover risks that networks create as "creative ordering." The term is meant to differentiate this form of contracting behavior from traditional private ordering while also evoking the context in which it arises—the development of new technology.

Creative ordering contributes normatively to a reconfiguration of the relationship between the state and market. Rather than being a peripheral institution, the legal system occupies center stage in the creatively ordered economy. Importantly, however, the central role of the legal system does not arise because social networks are weak.[24] Rather, it is the potency of the network itself that demands legal intervention. Robust social networks and formal legal institutions operate hand-in-hand.

This reconfigured relationship between state and market has normative implications in two major settings. The first setting is contract law. Creative ordering provides a new argument that courts should ignore private ordering advocates' sweeping claims that

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20. *iBio*, 2016 WL 4059257, at *1.

21. *Id.* at *4.

22. For a discussion of the growth of contractual complexity, see Cathy Hwang & Matthew Jennejohn, *The New Research on Contractual Complexity*, 14 CAP. MKTS. L.J. 381 (2019).

23. For a useful discussion of combining research methods, see Martyn Denscombe, *Communities of Practice: A Research Paradigm for the Mixed Methods Approach*, 2 J. MIXED METHODS RSCH. 270 (2008).

24. *See* Yoshinobu Zasu, *Sanctions by Social Norms and the Law: Substitutes or Complements?*, 36 J. LEGAL STUD. 379, 382 (2007) (finding that in modern society, where social connectedness is weak, undesirable acts are insufficiently deterred by social norms).

network governance can effectively substitute for formal contract law in a wide range of markets. Evidence that parties use formal contracts to address the risks that networks create, rather than use reputational sanctions, undercuts calls for minimal court intervention in contract disputes. To discourage courts from enforcing contractual obligations when parties are using contracts to address the spillovers that networks promote, is to cut innovative companies off from the very legal institutions upon which they rely. The private ordering thesis's prescription is exactly backwards. Contract law matters.

At the same time, the legal system's central role in creative ordering raises a difficult new normative issue for contract design and enforcement: Should contract law be used to limit spillovers? While costly for individual companies, who want to reap the profits from their proprietary technology, spillovers can be socially beneficial.[25] This issue has been a longstanding topic of debate in intellectual property scholarship.[26] Creative ordering brings it to the heart of contract theory.[27]

The second setting is the new industrial policy that is emerging in the United States,[28] an area that legal scholarship, with its preference for doctrinal analysis, might easily overlook. Creative ordering gives the administrative state a new tool for promoting economic development. In a sense, creative ordering democratizes innovation: new technology is developed through formal contracts and the standard legal system, rather than through private methods only the members of a specific commercial community can understand. That raises the possibility that creative ordering might be used not just between sophisticated private parties but also by the state itself. Indeed, evidence exists that this is

25. This possibility was first noted by the influential English economist, Alfred Marshall, over a century ago. *See* ALFRED MARSHALL, PRINCIPLES OF ECONOMICS 268 (8th ed. 1920); ALFRED MARSHALL, INDUSTRY AND TRADE: A STUDY OF INDUSTRIAL TECHNIQUE AND BUSINESS ORGANIZATION; AND OF THEIR INFLUENCES ON THE CONDITIONS OF VARIOUS CLASSES AND NATIONS 125–28, 599–610 (1919); ALFRED MARSHALL, THE PURE THEORY OF (DOMESTIC) VALUES 7–11 (1879). Later research has confirmed and deepened Marshall's insights. *See, e.g.*, Glenn Ellison et al., *What Causes Industry Agglomeration? Evidence from Coagglomeration Patterns*, 100 AM. ECON. REV. 1195 (2010) (discussing how all three of Marshall's theories of agglomeration are supported); Michael Greenstone et al., *Identifying Agglomeration Spillovers: Evidence from Winners and Losers of Large Plant Openings*, 118 J. POL. ECON. 536 (2010) (suggesting that knowledge spillover could be important in high-tech industries).

26. *See, e.g.*, Henry E. Smith, *Intellectual Property as Property: Delineating Entitlements in Information*, 116 YALE L.J. 1742 (2007) (discussing the extensive literature focused on knowledge spillover); LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD (2001) (arguing that a strict copyright regime would destroy the spirit of early internet innovation); SIVA VAIDHYANATHAN, COPYRIGHTS AND COPYWRONGS: THE RISE OF INTELLECTUAL PROPERTY AND HOW IT THREATENS CREATIVITY (2001) (arguing that excessively restrictive copyright law hinders cultural production); Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCIENCE 698 (1998) (discussing the anticommons, wherein people refrain from using scarce resources because too many owners block one another in biomedical research).

27. Spillovers have occupied a peripheral position in contract theory, with the most sustained attention applied to the enforceability of non-compete agreements in the employment context. *See, e.g.*, Ronald J. Gilson, *The Legal Infrastructure of High Technology Industrial Districts: Silicon Valley, Route 128, and Covenants Not to Compete*, 74 N.Y.U. L. REV. 575 (1999); Orly Lobel, *Enforceability TBD: From Status to Contract in Intellectual Property Law*, 96 B.U. L. REV. 869, 869 (2016) (arguing that non-compete agreements that incorporate intellectual property restraints "exact a high cost to innovation and job mobility."); Jonathan M. Barnett & Ted Sichelman, *Revisiting Labor Mobility in Innovation Markets* (Ctr. for L. & Soc. Sci. Rsch. Papers Series, Paper No. CLASS16-13), https://ssrn.com/abstract=2758854 [https://perma.cc/5TAN-JCXJ].

28. As discussed in Part III.B *infra*, for the first time in two generations, both major political parties in the United States are embracing a more robust form of industrial policy to stimulate development in key industries.

already happening. The contractual arrangements used by both the U.S. federal government and the European Union to develop COVID-19 vaccines and treatments exhibit the characteristics of creative ordering. This introduces an important new role for law in the economy: Contracting is the device by which 21st century industrial policy is pursued. And it raises the question of how creative ordering should be calibrated for this purpose.

This Article unfolds as follows. Part I introduces the paradox that private ordering scholarship has overlooked: Exchange networks may circulate reputational information that gives companies a governance benefit, but they also circulate technical information that presents companies with a governance cost. Part II then presents the results of the qualitative and quantitative empirical analysis of the biopharmaceutical industry, which provides evidence of how market participants address the costs of networks. The results of that analysis suggest that formal legal institutions, rather than informal sanctions, are crucial for addressing the costs of exchange networks. Part III introduces this Article's normative implications for emergent industrial policy, contract law, and future research on the relationship between law and markets. Finally, this Article concludes with a reflection on what is at stake in the policy debate to which this study contributes.

II. A PRIVATE ORDERING PARADOX

"Recently one of our alliance partners asked us if we would have an issue with them doing a related project with another partner. Yes, that's a whole new ball game."[29]

The quote above, taken from one of the practitioner interviews for this project, highlights the costs that networks pose for commercial parties. A contractual partner today may do a deal with a competitor tomorrow, thereby raising the possibility that one's valuable technology will leak to that third party.

This Part of the Article situates this new type of risk in the existing literature on contract design and private ordering, which has overlooked this type of risk. Our starting point in this journey is the trading community, or network of exchange relationships, that emerges as parties in a market contract with one another. To use a simple example, think of a farmer selling produce at a farmers' market. The farmer will have exchange relationships with the customers to whom the farmer sells. That creates a network, where the farmer and the customers are the nodes, and transactions between them are the links. And, of course, the farmer is a customer in their own right—they source seed, fertilizer, and equipment from various producers, thereby extending the exchange network. Every market is comprised of such networks.[30]

The exchange network provides a conduit for information to flow between parties. Even simple exchanges, like our farmers' market example, can facilitate the transfer of information. Try it yourself: next time you go to an outdoor market, ask a seller a question about how their produce was grown, and you will find yourself learning something new as information is exchanged.

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29. Interview #16.

30. *See* HARRISON C. WHITE, MARKETS FROM NETWORKS: SOCIOECONOMIC MODELS OF PRODUCTION 2 (2002) (advancing a "general theory of social construction, rooted in network, identity, and control and triggered by exposure to the uncertainties in ordinary business.").

In private ordering scholarship, that flow of information is critically important. When parties exchange information about reputations in the market, it provides the basis for an informal sanction for enforcing contracts. Gossip in the market enforces obligations. The farmer, for instance, does not sell poor-quality produce to customers due to the fear that the farmer's reputation will be harmed in the market as disgruntled customers spread the word.

There is, however, a second possibility that prior scholarship has overlooked. Connections between participants in a market may also circulate technical information, thereby exacerbating the risk of technological spillovers. In some markets, such as for commodity products, there may be little technical information of real value, and so this second cost may be minimal. However, in many modern markets that rely upon high technology, the costs of technical information spilling over to third parties can be enormous.

In short, private ordering sees information transfer in a network as a *benefit* to contracting parties, overlooking this second possibility that sees it as a *cost*. This Part of the Article introduces those two competing visions.

A. The Old Religion: Exchange Networks as Unalloyed Benefits

Private ordering has a long pedigree in legal scholarship. It begins with Macaulay's and Macneil's pioneering work on relational contract theory in the 1960s and 1970s, which recognized that social context is important to the enforcement of contractual obligations.[31] As Ellickson later described in his classic analysis of dispute resolution among Shasta County ranchers, social context affects both the definition of norms and their enforcement: "[M]embers of a close-knit group develop and maintain norms,"[32] and one form informal enforcement can take is "the sting of negative gossip" in the community.[33] Recent scholarship argues that reputational sanctions are available not only in closely knit trading communities, like Shasta County, but also the large global markets of the 21st century economy.[34] The common thread through all of this scholarship is that networks of relationships among participants in a market provide a useful "privately ordered" governance tool.

1. The Classic Contracting Problem: Uncertain Deals with Untrustworthy Parties

Why is private ordering needed in the first place? Can't parties just write down their obligations in an agreement and enforce them in a court if there is a breach? Unfortunately, it is often not so easy.

Many transactions require parties to coordinate their efforts into the future. Plans must be made, and there must be an expectation that those plans will be kept, before investment proceeds. Formal contracts are often considered tools for providing that certainty: Modern contract law's vindication of parties' expectation interests in the event of breach provides actors the certainty necessary to engage in significant investments. On the other hand,

31. Stewart Macaulay, *Non-Contractual Relations in Business: A Preliminary Study*, 28 AM. SOC. REV. 55 (1963); Ian R. Macneil, *Contracts: Adjustment of Long-Term Economic Relations under Classical, Neoclassical, and Relational Contract Law*, 72 NW. U. L. REV. 854 (1978).

32. ELLICKSON, *supra* note 2, at 167, 177–78.

33. *Id*. at 143, 214–15.

34. Bernstein, *Beyond Relational Contracts*, *supra* note 15, at 563.

because parties cannot fully anticipate future events, those formal agreements will inevitably be incomplete and, in turn, rigid as those events unfold. The inter-firm innovation processes analyzed in this Article are particularly uncertain: Parties often begin collaborations with rough, impressionistic plans, which are then revised as joint discovery progresses.[35] In summary, it is common to frame the challenge of designing contracts as a tension between competing needs for certainty and flexibility.[36]

Contractual incompleteness can be particularly problematic in situations where investment in relationship-specific assets is required.[37] An exchange requiring such 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.[38] 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 opportunism.[39]

2. How Informal Sanctions Work

Integrating production within the boundary of a single company is not the only solution to the problem of contractual incompleteness. Informal governance may also address the opportunism problem.[40] The key reason a privately ordered 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.[41] Further, informal enforcement may be more accurate than dispute resolution through public courts of law because market participants and not generalist judges determine whether promises have been breached.[42]

Informal sanctions are typically available in markets where deals between contracting parties repeat. Repeated deals are the basis for what scholars call "bilateral sanctions"—a

35. Jennejohn, *The Private Order of Innovation Networks*, *supra* note 16; *Braiding*, *supra* note 16.

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

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

38. Klein et al., *supra* note 37; Oliver Hart & John Moore, *Foundations of Incomplete Contracts*, 66 REV. ECON. STUD. 115, 118–20 (1999); Klein, *Why Hold-Ups Occur*, *supra* note 37.

39. 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. *See generally* Klein et al., *supra* note 37; 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).

40. *See generally* Barak D. Richman, *Firms, Courts, and Reputation Mechanisms: Towards a Positive Theory of Private Ordering*, 104 COLUM. L. REV. 2328 (2004).

41. WILLIAMSON, *supra* note 39.

42. *See* Clive Bull, *The Existence of Self-Enforcing Implicit Contracts*, 102 Q.J. ECON. 147, 148–49 (1987) (looking at how market actors prevent breach of noncontractual employment agreements).

repeat player can credibly threaten to end a commercial relationship, which discourages bad behavior.[43] If that repetition occurs evenly within a homogenous, or "closely-knit," trading community, then a repeat player has a second enforcement tool: credibly threatening to disparage a poorly behaving counterparty's reputation in the market.[44] In either case, it is the prospect of sanctions being applied in a subsequent transaction that disciplines behavior in the current deal. In his famous work on medieval Maghribi merchants, Greif refers to this as "intertransactional linkage."[45] Linking transactions through repeated dealings between two parties creates the stability required for consistent norms to emerge[46] and allows an aggrieved party to punish an opportunistic counterparty, such as by terminating the relationship.[47] In summary, the answer to the hold-up problem may be extra-legal.

The primary normative implication arising from the private ordering literature is that legal institutions may interfere with informal governance. Law may "crowd out" efficient informal social sanctions by undermining the trust between parties.[48] Examples from everyday life abound. Many interactions in family relationships, intimate relationships, and friendships are not governed through formal contracts.[49] Indeed, reducing those interactions to a formal agreement might signal that you distrust that person. That may explain why few of us memorialize domestic obligations, such as taking out the garbage and washing the dishes, in a contract and then expect to enforce it in court if a dispute arises.

3. An Expansive Role for Networks

For decades, much scholarship assumed that the role of reputational sanctions was limited to insular trading communities, where social connections are tight.[50] However, in two important recent papers, Bernstein argues that the scale of informal enforcement in relational contracting is greater than prior scholarship has appreciated. The core claim is that the reputational sanctions observed in closely-knit cliques are also available in large

43. *See generally* Peter Moran, *Structural vs. Relational Embeddedness: Social Capital and Managerial Performance*, 26 STRATEGIC MGMT J. 1129 (2005); Macaulay, *supra* note 31; Macneil, *supra* note 31.

44. Bernstein, *supra* note 3.

45. GREIF, *supra* note 10, at 47–50; *see also* Greif, *supra* note 4, at 525, (discussing the relationship between social and economic institutions).

46. GREIF, *supra* note 10,. at 59.

47. *See generally* B. Douglas Bernheim & Michael D. Whinston, *Incomplete Contracts and Strategic Ambiguity*, 88 AM. ECON. REV. 902 (1998); W. Bentley MacLeod & James M. Malcomson, *Implicit Contracts, Incentive Compatibility, and Involuntary Unemployment*, 57 ECONOMETRICA 447 (1989); W. Bentley MacLeod & James M. Malcomson, *Reputation and Hierarchy in Dynamic Models of Employment*, 96 J. POL. ECON. 832 (1988); L. G. Telser, *A Theory of Self-Enforcing Agreements*, 53 J. BUS. 27 (1980).

48. *See supra* note 3 and accompanying text for scholarship on how rigid rules can undermine efficiency.

49. *See* Elizabeth Scott & Robert Scott, *Marriage as a Relational Contract*, 84 VA. L. REV. 1225, 1242 (1998) (discussing the persistence of private ordering within the institution of marriage).

50. A small cottage industry of ethnographic studies has arisen, covering everything from sovereign debt to tuna merchants in Tokyo to 11th century Jewish merchants in North Africa to organized crime to land courts in Papua New Guinea. *See generally* Sadie Blanchard, *Courts as Information Intermediaries: A Case Study of Sovereign Debt Disputes*, 2018 BYU L. REV. 497 (2018); Eric A. Feldman, *The Tuna Court: Law and Norms in the World's Premier Fish Market*, 94 CALIF. L. REV. 313 (2006); Curtis J. Milhaupt & Mark D. West, *The Dark Side of Private Ordering: An Institutional and Empirical Analysis of Organized Crime*, 67 U. CHI. L. REV. 41 (2000); Robert D. Cooter, *Inventing Market Property: The Land Courts of Papua New Guinea*, 25 LAW & SOC'Y REV. 759 (1991).

markets, where reputational sanctions amplify bilateral threats to stop dealing in the future.[51] In the second paper, Bernstein then adds an important corollary: a small world network structure promotes the information flows upon which this expanded informal governance relies.[52]

Bernstein introduces the network governance thesis in the context of heavy equipment supply chains.[53] Based on interviews with subjects originally identified in Whitford's excellent study of collaboration among heavy equipment suppliers in the upper Midwest of the United States,[54] Bernstein finds qualitative evidence that suppliers operate within a network of relationships that limit the risk of opportunistic behavior by amplifying reputational sanctions.[55] The potency of those informal sanctions varies according to parties' centrality within the network—more centrally located parties are more constrained by the possibility of reputational sanctions.[56] For instance, interviewees note that an original equipment manufacturer ("OEM") that has many connections is constrained from opportunistically invoking at-will termination provisions in its formal agreement with a supplier, because the news of doing so will quickly spread through the network, and other suppliers will demand a premium from that OEM in the future.[57]

Bernstein's recent work opens bracing new possibilities in the private ordering literature. An informal governance mechanism that appeared isolated to niche trading communities may be available in a wide range of markets. The scale of private ordering may be much larger than we assumed.[58]

B. A New Perspective: The Overlooked Costs of Exchange Networks

This Section introduces an alternative theory of networks' role in relational contracting that departs fundamentally from private ordering theory, which principally takes the hold-up threat as its starting point. If hold-up is the key contracting problem, then

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51. Bernstein, *Beyond Relational Contracts*, *supra* note 15, at 563, 564 n.7.

52. Bernstein, *Contract Governance in Small World Networks*, *supra* note 10*,* at 1014–15.

53. Bernstein, *Beyond Relational Contracts*, *supra* note 15, at 562–65.

54. JOSH WHITFORD, THE NEW OLD ECONOMY: NETWORKS, INSTITUTIONS, AND THE ORGANIZATIONAL TRANSFORMATION OF AMERICAN MANUFACTURING (2005).

55. Bernstein, *Beyond Relational Contracts*, *supra* note 15**,** at 578–86.

56. *Id*. at 604–06.

57. *Id*. at 605 (arguing that reputational information circulating within the network "has the potential to damage the OEM's reputation . . . . Misbehaving OEMs may be charged a higher price to reflect the perceived risk of dealing with them . . . .").

58. Like all pioneering contributions to scholarship, Bernstein's network governance thesis leaves open a number of important questions for subsequent research to address. Most important among these is the fact that Bernstein's recent work does not squarely address the question of whether network governance is a substitute for or complement to formal contract institutions. At times, Bernstein appears to think of network and contract in a complementary fashion—e.g., formal agreements are simply used to foster the "emergence of cooperative contracting relationships," and presumably network governance takes over. *Id*. at 576–96 (discussing the use of master supply agreements to facilitate cooperation in heavy equipment supply chains); *see also* Bernstein, *Contract Governance in Small World Networks*, *supra* note 10, at 1052–55 (arguing that formalities, such as written contracts, are consistent with informal reputational enforcement). However, Bernstein relies upon empirical studies that find evidence of a substitutionary relationship between parties' network centrality and formal governance, as a centerpiece of her network governance argument. *See* Bernstein, *Beyond Relational Contract*s, *supra* note 15, at 600–03. Overall, the normative thrust of the network governance thesis appears to be that, where network governance is available, formal contract law is less important to modern exchange than we might otherwise assume, and that is the basis on which this paper will proceed. *Id.* at 563.

it is natural to view networks are a source of reputational sanctions, which constrain a party from acting opportunistically.

However, what if opportunism is not the only problem bedeviling contracts? Interviews with practitioners who are regularly involved with biopharmaceutical alliances indicate that opportunism problems are not always parties' paramount concern. As one interviewee noted, "[o]pportunism problems really only arise in rare situations with an idiosyncratic founder at a small company."[59]

This Section outlines an additional hazard affecting contracts—namely, spillover problems that sit alongside opportunism risks.[60] It then argues that more connections in a network can exacerbate spillover problems, even as the network may mitigate opportunistic hold-up. Building upon well-established social science research, it argues that networks do not present unalloyed benefits for transacting parties. Rather, becoming more "embedded" within a network increases the risk of technological spillovers—ownership of jointly developed intellectual property becomes ambiguous as a company has more alliances, and a project with one partner may lead to technology leaking to third parties, or otherwise close off opportunities with another partner.

1. Beyond Opportunism

Collaborating with another company to develop new technology increases the possibility that one's proprietary technology will spill over to third parties. A consistent refrain in the practitioner literature on technology alliances is the importance of intellectual property issues in collaborations.[61] A number of the practitioners interviewed for this project also noted the salience of concerns about intellectual property ownership.[62] Exclusive control over assets cannot be taken for granted.[63] Resources must be spent policing the boundaries of one's assets and, if necessary, excluding others attempting to encroach.[64] Where the use of an asset in question is non-rivalrous, such as with intangible

59. Interview #2; *see also* Interview #1 (arguing that hold-up problems are often not acute due to the relatively modest amounts of capital required).

60. The effect of spillover and coordination problems is explored in earlier work. *See generally* Jennejohn, *supra* note 28.

61. Review of the practitioner literature indicates that the prospect of intellectual property spillovers often dominate collaborating parties' attention. *See*, *e.g.*, DELOITTE SWITZERLAND, STRATEGIC ALLIANCES IN LIFE SCIENCES: ARE YOU READY? 5 (2017) ("[B]y combining the knowledge of two or more entities, the imminent danger of safeguarding intellectual property (IP) is a daily occurrence."); Martha Bair Steinbock, *How to Draft a Collaborative Research Agreement*, *in* INTELLECTUAL PROPERTY MANAGEMENT IN HEALTH AND AGRICULTURAL INNOVATION: A HANDBOOK OF BEST PRACTICES 721 (Anatole Krattiger et al. eds., 2007), http://www.iphandbook.org/handbook/ch07/p04/ [https://perma.cc/U9AM-3P37] ("Perhaps the most important section of the general provisions [of an alliance contract] deals with the intellectual property . . . provisions.").

62. Interview #1 (noting that technology spillovers can be particularly concerning where the financing partner has an internal microbiology team); Interview #3 (noting that joint ownership of intellectual property is a concern).

63. *See* Mark A. Lemley & Carl Shapiro, *Probabilistic Patents*, J. ECON. PERSP., Spring 2005, at 75, 76 ("Virtually all property rights contain some element of uncertainty."). Defining property rights in any context is costly. *See* Gary D. Libecap, *A Transaction-costs Approach to the Analysis of Property Rights*, *in* THE ECONOMICS OF CONTRACTS: THEORIES AND APPLICATIONS 140, 146 (Eric Brousseau & Jean-Michel Glachant eds., 2002).

64. *See* Steven N.S. Cheung, *The Structure of a Contract and the Theory of a Non-Exclusive Resource*, 13 J. L. & ECON. 49, 67 (1970) (noting that an exclusive property right is predicated upon unstinting delineation and defense of the right's limits).

goods, then defining and enforcing one's property rights can be particularly costly, given the ease with which the asset's value can be misappropriated.[65] Property rights can be uncertain.[66] As a result, spillovers occur as information leaks from one party to another.[67]

A growing body of scholarship examines how spillovers affect market structure and firm boundaries. Research 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.[68] 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.[69] This, in turn, suggests that other formal governance tools, such as contracts, may be used to address those spillover problems. Before we consider that possibility, however, we must first consider how network structure interacts with spillover issues.

2. How Network Position Can Exacerbate Those New Problems

Having more connections—or becoming more "embedded"—within a network exacerbates spillover risks. Collaborating with a company centrally positioned in the

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65. Brett M. Frischmann & Mark A. Lemley, *Spillovers*, 107 COLUM. L. REV. 257, 272–74 (2007).

66. Property rights are rarely completely defined, and some uncertainty as to ownership is common. Problems arise where, due to high costs of defining a property right, that uncertainty becomes so pronounced so as to impede exchange. *See* Thomas W. Merrill, *Trespass, Nuisance, and the Costs of Determining Property Rights*, 14 J. LEG. STUD. 13, 24 (1985) ("To be sure, uncertainty about who holds the property right is not invariably fatal to an agreement. . . However, if the parties differ in their estimate of the probability of who holds the right, or in their preference for risk, then there may be no range of bid and asked prices within which they can agree on an exchange.").

67. Frischmann & Lemley, *supra* note 65, at 262, 265 (defining spillovers as "direct benefits (or costs) realized by third parties—agents who are not participating in the relevant market and thus have not transacted with the provider of the benefits or costs").

68. *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).

69. *See* Oren Bar-Gill & Gideon Parchomovsky, *Law and the Boundaries of Technology-Intensive Firms*, 157 U. PA. L. REV. 1649, 1656–57 (2009) (noting stronger intellectual property rights contribute to the viability of small specialized firms and favor independent suppliers over vertical integration); *see also* Robert P. Merges, *Intellectual Property Rights, Input Markets, and the Value of Intangible Assets* 1, 3 (Feb. 9, 1999) (unpublished manuscript), https://www.law.berkeley.edu/files/iprights.pdf [https://perma.cc/FF8Z-G6LV] (noting that while vertical growth is still common via acquisition, large firms often partner with small firms steeped in new technology.) Another strand of research examines how intellectual property law affects transaction costs. *See, e.g.*, Dan L. Burk & Brett H. McDonnell, *The Goldilocks Hypothesis: Balancing Intellectual Property Rights at the Boundary of the Firm*, 2007 U. ILL. L. REV. 575, 576–77; Dan L. Burk, *Intellectual Property and the Firm*, 71 U. CHI. L. REV. 3, 18 (2004) (arguing that intellectual property law reflects Hart's theory of the firm); Paul J. Heald, *A Transaction Costs Theory of Patent Law*, 66 OHIO ST. L.J. 473, 476–77 (2005) (arguing that patents respond to team production and asset partitioning problems within the firm).

An example of vertical integration in response to spillover problems is Google's 2011 acquisition of Motorola Mobility Inc., understood as a move to protect Google's Android mobile operating system and its valuable ecosystem of app developers from patent infringement claims. *See, e.g.*, Shira Ovide, *Google-Motorola: It's All About the Patents*, WALL ST. J.: DEAL J. (Aug. 15, 2011, 10:03 AM), http://blogs.wsj.com/deals/2011/08/15/google-motorola-its-all-about-the-patents [https://perma.cc/TW3C-24GM].

network increases the likelihood that technical information will leak out.[70] This is particularly problematic if one's current partner can later collaborate with one's competitors, as happened in the *iBio v. Fraunhofer* example above.[71] That is a frequent occurrence, as Powell et al. note: "[t]he pattern of cross-cutting collaborations [in biopharmaceuticals] often results in a partner on one project being a rival on another."[72]

The idea that network connections can increase spillover risk is a new twist on an old theme in economic sociology. Granovetter's classic article on socially-embedded exchange recognized that network connections can introduce costs, not just benefits, for parties.[73] Uzzi's subsequent work built upon that foundation, introducing the idea that networks introduce a "paradox of embeddedness."[74] 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 were more socially embedded with their suppliers performed poorly compared to participants with a mix of embedded and arm's-length contractual arrangements.[75] Uzzi argues that being densely embedded in a network with many redundant ties reduces the flow of novel information because few of the market players have unique connections. Information becomes ossified, and collaborations fail due to a "paucity of competence" instead of a surfeit of opportunism.[76] The spillover risks focused on in this Article add an additional dimension to that work. Greater embeddedness may not only close an actor off from new sources of information, it may also provide a conduit for an actor's proprietary technology to leak out into the market.[77]

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70. *Braided Agreements*, *supra* note 16, at 268–69.

71. See *supra* note 18–20 and accompanying text for a recitation of the iBio fiasco.

72. Powell et al., *supra* note 11, at 1187. Heller & Eisenberg, *supra* note 26, at 701.

73. Mark Granovetter, *Economic Action and Social Structure: The Problem of Embeddedness,* 91 AM. J. SOC. 481, 487–93 (1985) (noting that networks can circulate not only accurate information useful for policing opportunism but also inaccurate information that undermines informal sanctions).

74. Brian Uzzi, *Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness*, 42 ADMIN. SCI. Q. 35, 57 (1997) [hereinafter Uzzi, *Social Structure*]; Brian Uzzi, *The Sources and Consequences of Embeddedness for the Economic Performance of Organizations: The Network Effect*, 61 AM. SOCIO. REV. 674, 694–698 (1996) [hereinafter Uzzi, *Sources and Consequences*]. In its essence, the paradox of embeddedness is similar to the lock-in problem that arises from the standardization of formal contract terms. Standardization of formal terms can be used to address common exchange hazards across similar deals, which reduces mundane drafting costs and sends a quality signal, which in turn may free up resources to fine-tune portions of the agreement addressing novel contingencies. *See generally* Michael Klausner, *Corporations, Corporate Law, and Networks of Contracts*, VA. L. REV. 757, 851 (1995); Marcel Kahan & Michael Klausner, *Path Dependence in Corporate Contracting: Increasing Returns, Herd Behavior and Cognitive Biases*, 74 WASH. U. L. Q. 347, 348 (1996); Marcel Kahan & Michael Klausner, *Standardization and Innovation in Corporate Contracting (Or "The Economics of Boilerplate")*, 83 VA. L. REV. 713, 719 (1997). However, as recent research on the *pari passu* clause in sovereign debt indentures has demonstrated, contractual standardization also has a dark side. *See generally* MITU GULATI, THE THREE AND A HALF MINUTE TRANSACTION: BOILERPLATE AND THE LIMITS OF CONTRACT DESIGN (2013), Terms standardized across a market can become locked-in as transaction designers reap increasing returns to scale, as parties come to view deviations from the market standard as signals of non-sophistication or as the original meaning of a term becomes lost to memory. In short, standardized provisions can become stuck in the rut of collective action problems, and in that respect there is a common foundation to the paradox of embeddedness and boilerplate lock-in.

75. Uzzi, *Social Structure*, *supra* note 74, 58–59; Uzzi, *Sources and Consequences*, *supra* note 74, at 694.

76. *Id.*

77. Practitioner commentary notes this risk. As one leading practitioner described when discussing a new

C. Summary: Two Views of the Information that Diffuses in a Network

The discussion above introduces two very different views of networks' role in contracting. According to conventional private ordering theory, networks of relationships among market participants are a benefit. They provide a basis for informal governance in the form of reputational sanctions. That is, if a party threatens to opportunistically breach the terms of an agreement, the other party can spread the word of that breach in the network, which raises costs for the breaching party as it seeks future deals in the market.

The possibility of network costs introduced here sees networks in a different light. The network of relationships among participants in a market can have a dark side in the sense that greater connections make technological spillovers more likely. A large body of research, which has been entirely overlooked in contract theory, supports the idea that networks can also present costs, not only benefits.

Simply put, two types of information can diffuse throughout a network: reputational information and technical information. The diffusion of reputational information is a benefit that can be used to enforce contractual commitments. The diffusion of technical information is a problem for innovating companies who may use formal contracts to address that issue.

The question then arises of whether we can determine which type of information affects contracting behavior. Do we see evidence of parties using networks to constrain opportunistic breaches? Or do we see evidence of parties trying to mitigate the risks networks create? Those empirical questions are the focus of the next Part of this Article.

III. ADDRESSING NETWORKS' COSTS: JOINT DISCOVERY IN BIOPHARMACEUTICALS

"Nobody does a biotech alliance on a handshake."[78]

This Part of the Article provides empirical evidence that parties use formal legal institutions to address the spillover risks that network connections exacerbate. The study analyzes how biopharmaceutical companies organize the joint development of new drugs. The biopharmaceutical industry is studied for two reasons. Since the first R&D alliance between Genentech and Eli Lilly in 1978, collaboration between companies has been a hallmark of the industry. Biotech and pharmaceutical companies enter into thousands of alliances each year, creating a rich network of contractual relationships.[79] Furthermore, a

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gene editing technology, known as "CRISPR," where many companies are developing competing solutions:

> [L]ike other early-stage fields, CRISPR is a high-risk market. There are some really important strategic decisions to make. . . . If you choose to take a license, who do you take it with and why? What is the state of their IP protection and what is its potential for growth? How will that affect your possibilities for future CRISPR collaboration?

Adam Houldsworth, *Revolutionary Change in CRISPR Patent Landscape Poses Tough Questions for Life Sciences Companies*, IAM (Jul. 27, 2018), https://www.iam-media.com/litigation/revolutionary-change-crispr-patent-landscape-poses-tough-questions-life-sciences [https://perma.cc/5HAS-CC38] (quoting Daniel Lim, then attorney at Allen & Overy).

78. Interview #2.

79. As a result, the engine of 21st century medicinal innovation is a rich, extensive network, with concentrated clusters of collaborators in San Diego, Boston, the Bay Area, and, to a lesser extent, a number of additional cities. *See, e.g.*, Walter W. Powell et al., *Organizational and Institutional Genesis: The Emergence of*

significant amount of detailed data on biopharmaceutical alliances is publicly available.[80]

To paint as comprehensive and accurate a picture as possible, the study combines quantitative methods that are new to legal scholarship and familiar qualitative methods that, hopefully, will never go out of style in private law research.[81] Pains are taken throughout the discussion in this Part to present the analysis in plain English for readers that are not familiar with the biopharmaceutical industry or the empirical methods used here. Details on the qualitative interview methodology can be found in the Appendix, along with more detailed presentations of the regression results.

As the quote opening this Part indicates, the study finds evidence that parties in the biopharmaceutical industry use formal contracts to govern their relationships and do not rely on private ordering. That evidence is presented in the following steps.

First, this Part provides background context for readers unfamiliar with the biopharmaceutical industry. It explains the financing and technological necessities that drive companies in the biopharmaceutical industry to use contractual alliances to develop new drugs.

Second, this Part provides a panoramic picture of the network of contractual relationships in the biopharmaceutical industry. It maps twenty years of alliance relationships in the biopharmaceutical industry, giving us a bird's-eye view of collaboration in drug development. That map reveals a dynamic network where companies

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High-Tech Clusters in the Life Sciences, *in* THE EMERGENCE OF ORGANIZATIONS AND MARKETS 434 (John F. Padgett & Walter W. Powell eds. 2013) (discussing processes and mechanisms that foster catalytic growth in communities); Kjersten Bunker Whittington et al., *Networks, Propinquity, and Innovation in Knowledge-Intensive Industries*, 54 ADMIN. SCI. Q. 90 (2009) (discussing the joint effects of geographic propinquity and network position on organizational innovation using negative binomial count models); Steven Casper, *How Do Technology Clusters Emerge and Become Sustainable?: Social Network Formation and Inter-Firm Mobility within the San Diego Biotechnology Cluster*, 36 RSCH. POL'Y 438 (2007) (describing the social network analysis to examine the emergence of social networks linking senior managers employed in biotechnology firms in San Diego, California).

80. Many alliance agreements are filed with the Securities and Exchanges Commission as part of public companies' mandatory reporting obligations, which has led to a fairly large literature on biopharmaceutical contracting. *See*, *e.g.*, Karen E. Sandrik, *Innovative Contracting for Better Material Transfers*, 24 TEX. INTELL. PROP. L.J. 49 (2016).

81. Methods for network analysis have only recently begun to be used in legal research. *See* Ryan Whalen, *Legal Networks: The Promises and Challenges of Legal Network Analysis*, 2016 MICH. ST. L. REV. 539 (2016) (introducing network analysis methods and identifying areas where they promise to shed light on legal issues). Network analysis methods have yet to be widely exploited in legal research on contract design and enforcement. Some limited first steps have been made. For instance, prior work by Robinson & Stuart studies the relationship between network structure and certain formal governance tools, but they do not analyze discrete contract terms in detail. David T. Robinson & Toby E. Stuart, *Financial Contracting in Biotech Strategic Alliances*, 50 J. L. & ECON. 559 (2007) (analyzing variables such as contract length and equity participation but not the language of actual contract terms in biotechnology alliances); *see* David T. Robinson & Toby E. Stuart, *Network Effects in the Governance of Strategic Alliances*, 23 J. L., ECON., & ORG. 242 (2007) (studying equity participation and pledged funding in biotechnology alliances). Bernstein's 2015 paper does analyze discrete contract terms in detail, but it does not quantitatively analyze network structure. Gelderblom, *supra* note 5; *see also Braiding*, *supra* note 16 (analyzing contract terms but not network structure).

Qualitative methods, such as the semi-structured interviews used here, have a long pedigree in private law scholarship. The following works all rely on qualitative interviews. *See*, *e.g.*, Macauley, *supra* note 1; Landa, *supra* note 2; Bernstein, *supra* note 2; Bernstein, *supra* note 3; Lisa Bernstein, *The Questionable Empirical Basis of Article 2's Incorporation Strategy: A Preliminary Study*, 66 U. CHI. L. REV. 710 (1999); Richman, *supra* note 2; Feldman, *supra* note 50; Gillian K. Hadfield & Iva Bozovic, *Scaffolding: Using Formal Contracts to Support Informal Relations in Support of Innovation*, 2016 WIS. L. REV. 981 (2016).

ally with one another in unpredictable ways. The many connections in the network make spillovers possible, but the unpredictability of those connections makes it difficult for any given company to anticipate with precision where its technology may spill over.

Third, this Part explains why patents do not provide a simple solution to that spillover problem. Entering into an alliance often blurs intellectual property rights, making patents an incomplete solution to spillovers. When two companies co-develop a drug, they often jointly own the patent(s) to that compound. This discussion shows how the default rules of U.S. patent law do not protect biopharmaceutical companies from the spillover risks that joint ownership poses. In short, property rights are an incomplete solution, and biopharmaceutical companies that wish to prevent spillovers must turn to contracts as an alternative.

Fourth, this Part explains the specifics of how biopharmaceutical companies design alliance contracts to address the spillover risks that patents do not fully address. This discussion focuses upon unique governance mechanisms in biopharmaceutical alliances that, according to the practitioners and executives interviewed for this Article, limit spillovers.

Fifth, this Part presents evidence that parties use unique contractual tools more often as their connections within the biopharmaceutical network grow. The more central companies are in the network, the more likely they are to use those formal contract devices. These correlations alone do not establish causality. However, when combined with the interview evidence, they are strongly suggestive that formal contracts address the heightened spillover risks that come with more network connections.

Finally, this Part summarizes the results of the study and addresses potential counterarguments. In sum, what we see is a highly interconnected industry where spillover risk is acute. To whom one's technology may spill over is difficult to predict, because alliancing among companies does not follow predictable patterns. Because patent law provides an incomplete solution, biopharmaceutical companies design contracts that address spillover risk. As spillover risk grows with more network connections, parties increase their use of formal contracting. That positive correlation is consistent with the Article's argument that formal law is used to address the costs networks present, and it is just the opposite of what traditional private ordering theory predicts.

A. Collaborating to Create New Drugs

In many industries, companies relentlessly innovate in order to avoid the dismal profitability of selling commoditized products.[82] Often, achieving successful innovation at a rapid rate cannot be achieved internally at a single company, and so companies collaborate on the development of new technology, combining their expertise, information, and resources to realize new discoveries that would otherwise be out of reach. Invention takes a village.[83]

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82. *See, e.g.*, Henry W. Chesbrough, *The Case for Open Services Innovation: The Commodity Trap*, 53 CAL. MGMT. REV. 5 (2011) (discussing how firms need to engage customers in the service innovation process and employ open innovation as a means to accelerate and deepen service innovation).

83. *See* Ashish Arora et al., *The Changing Structure of American Innovation: Cautionary Remarks for Economic Growth*, (Nat'l Bureau of Econ. Rsch., Working Paper No. 25893, 2019), https://www.nber.org/papers/w25893 [https://perma.cc/Z8QP-J58N] (discussing the development of a growing division of labor and, in turn, a more contractual approach to innovation in the United States). The network as a

Biopharmaceuticals is one of those industries where collaboration is common. Creating a new drug is an incredibly costly, uncertain, and time-consuming process: the costs of clinical trials alone for a mainstream pharmaceutical in 2019 was estimated to be $291 million.[84] Collaboration has been popular in the industry for decades as a strategy for dispersing the exorbitant costs and the inherent uncertainty of drug development.[85] Collaboration often gives established pharmaceutical firms and new biotech entrants access to technology, know-how, and financing that is otherwise out of reach. Many research-focused biotechnology companies lack capital and certain types of expertise, such as navigating regulatory processes and product marketing.[86] Financing is often secured either through the venture capital market or through contractual alliances with larger industry players.[87] Those alliance relationships are often a source of not only capital but also expertise—in the sense that the more established partner, such as a longstanding pharmaceutical firm, cooperates in the development of the technology, shepherds the drug through regulatory approval, and guides the marketing strategy. Such alliances are attractive for more established companies, which increasingly struggle to innovate drugs internally.[88]

B. Collaboration Leads to a Rich but Unpredictable Industry Network

The perils of sharing discoveries in biotechnology might be minimal if companies cooperated with the same small set of companies over time. This would lead to many small clusters of collaborators in an industry disconnected from one another. In that situation, one might not be too concerned about one's technology leaking widely throughout the marketplace.

However, collaborations with a circumscribed group of partners is not the norm in the biotechnology industry. Rather, companies routinely search far and wide for new partners, who may have new technology or ideas that could result in the next big blockbuster drug. Researchers have likened it to a ball, where dancers constantly move around the room to

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locus of innovation is a persistent theme in economic sociology. *See* HARRISON C. WHITE, MARKETS FROM NETWORKS: SOCIOECONOMIC MODELS OF PRODUCTION 1 (2002) ("An increasing number of markets are something more than sites for direct transactions between buyers and seller. These markets are mobilizers of production in networks of continuing flows . . . . [These networks] induce and adapt flows in production and service."); Walter W. Powell et al., *supra* note 11 (analyzing networked innovation in the biotechnology industry). For the leading analysis of the public policy issues arising from networked production, see YOCHAI BENKLER, THE WEALTH OF NETWORKS: HOW SOCIAL PRODUCTION TRANSFORMS MARKETS AND FREEDOM (2006).

84. Kavisha Jayasundara et al., *Estimating the Clinical Cost of Drug Development for Orphan versus Non-Orphan Drugs*, 14 ORPHANET J. RARE DISEASES (2019), https://ojrd.biomedcentral.com/articles/10.1186/s13023-018-0990-4 [https://perma.cc/P67L-A3L5].

85. For an insightful discussion of the nature and quality of innovation in biotechnology and pharmaceuticals, see Nicholson Price, *The Cost of Novelty*, 120 COLUM. L. REV. 769, 802–03 (2020).

86. Frank T. Rothaermel & Warren Boeker, *Old Technology Meets New Technology: Complementarities, Similarities, and Alliance Formation*, 29 STRAT. MGMT. J. 47, 50–51 (2008); Haibin Yang et al., *Exploration or Exploitation? Small Firms' Alliance Strategies with Large Firms*, 35 STRAT. MGMT. J. 146, 148 (2014).

87. Sean Nicholson, *Financing Research and Development*, OXFORD HANDBOOKS ONLINE, http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199742998.001.0001/oxfordhb-9780199742998-e-3 [https://perma.cc/57VS-BCJZ].

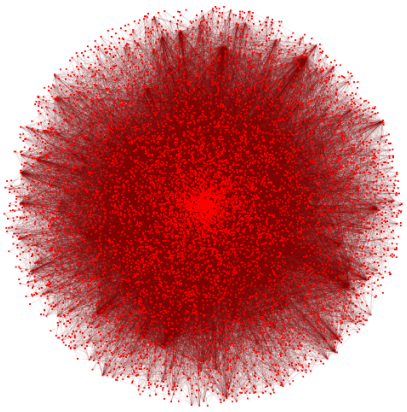
88. Larger pharmaceutical companies may also use alliances as preludes to a complete acquisition. *See* Matthew J. Higgins & Daniel Rodriguez, *The Outsourcing of R&D Through Acquisitions in the Pharmaceutical Industry*, 80 J. FIN. ECON. 351, 381 (2006); Weilei (Stone) Shi & John E. Prescott, *Sequence Patterns of Firms' Acquisition and Alliance Behaviour and their Performance Implications*, 48 J. MAN. STUD. 1044, 1049 (2011).

find new partners.[89]

Using tools from network analysis we can visualize the network that emerges from that partnering over time. Figure 1 below depicts the global network of collaborative relationships in the biotechnology industry from 1995 through 2015.[90] Each node in the network is a company, and each link connecting two nodes represents a formal contract.[91] Over 32,000 contracts, involving over 15,000 parties, are captured in the network.[92]

FIGURE 1: NETWORK GRAPH OF THE

BIOTECH ALLIANCE NETWORK, 1995–2015[93]



89. Walter W. Powell et al., *Network Dynamics and Field Evolution: The Growth of Interorganizational Collaboration in the Life Sciences*, 110 AM. J. SOC. 1332, 1138 (2005); *see also* Powell et al., *supra* note 11, at 142–43 ("[T]he locus of innovation is found within the networks of interorganizational relationships that sustain a fluid and evolving community"). In related work, Powell and Owen-Smith find that the central firms in biotechnology are an "open elite" with heterogeneous characteristics, a phenomenon that facilitates "crosstalk among a diverse set of organizations." Walter W. Powell & Jason Owen-Smith, *An Open Elite: Arbiters, Catalysts, or Gatekeepers in the Dynamics of Industry Evolution?*, *in* THE EMERGENCE OF ORGANIZATIONS AND MARKETS 467 (John F. Padgett & Walter W. Powell, eds., 2012).

90. For details on the sources for the data on alliance relationships, see *infra* Part VI.

91. Every network has two fundamental elements: the entities, or "nodes," of the network and the connections, or "links," between them. The nodes of the Biotech Alliance Network are separate companies, such as Pfizer, GlaxoSmithKline, and Genentech. Those nodes are then connected by a link when there is a contractual relationship between two companies. If two companies have more than one contract between them, the link is weighted to reflect the multiple agreements.

92. Most agreements involved two parties, but a small percentage of contracts involved three or more distinct organizations.

Of course, there are other types of connections between companies in the network besides formal contracts. For instance, there are professional and personal relationships among the scientists, academics, executives, and lawyers at the companies and institutions involved in the biotechnology industry. It is common, for instance, for scientists to move between companies and academic departments over the course of their career. Interview #4 (noting that "people in the industry move around"). Observing these connections among individuals at the scale sought here is difficult, and their role in the governance of alliance relationships is an important topic for subsequent—likely qualitative—research.

93. Analysis and visualization of the biotech network were accomplished with version 3.0.9.9.33 of the ORA-Netscenes software developed by researchers at Carnegie-Mellon and Netanomics.

Biotech companies' persistent search for novel partners creates a network of relationships in the industry that exacerbates spillover risk in two respects. First, it results in a single large, highly interconnected network of relationships among companies. Biotech is not a series of tiny clusters of companies isolated from one another, which naturally limits the diffusion of technical information in the industry. Rather, the biotechnology industry is a single interconnected network with a core and a periphery. Some companies, which are found at the center of the network, have many connections with other companies.[94] For instance, the most connected company, Pfizer, Inc., has 2,630 links to other companies in the network.[95] Most companies, however, have far fewer connections—the majority only have one or two links to other firms.[96] The core/periphery structure of the network exacerbates spillover concerns.[97] Studies have shown that diffusion accelerates when it passes through the core of a network.[98] To collaborate with a highly connected company, such as Pfizer, is to work with a partner that can potentially share your proprietary technology with many third parties.

Second, deals infrequently repeat between companies, which makes the connections between companies more unpredictable. Of the over 32,000 transactions in the dataset here, only 22.71% are repeated deals between two partners. Furthermore, more often than not, established companies collaborate with peripheral companies, rather than other companies with many connections. The Biotech Alliance Network's "assortativity" figure is negative: -0.182 on a scale from -1 to 1. This means that the most central companies in the network connect more frequently with peripheral firms than with other central players. In that respect, the Biotech Alliance Network is unlike many social networks, where central nodes tend to connect most often with other central nodes over time in a "rich-get-richer" dynamic.[99] This is consistent with established firms constantly searching for market entrants with new technologies and expertise. Frequent connections to new entrants make it difficult to predict where one's technology may travel.

C. Property Rights Blur as Collaborators Share Discoveries

At first glance, biopharmaceutical companies may appear to have an easy solution to the spillover problem that having many network connections creates: patent rights. Why can't a company simply stop spillovers by claiming a third party is infringing its patents?

Patents are an incomplete solution because, in many cases, the patent for a particular drug is owned by both of the companies that collaborated on its development. In the biopharmaceutical industry, a popular way to structure collaboration between two companies is through a contractual "alliance," often referred to as a collaboration agreement. These contractual alliances are a type of legal hybrid. As a leading treatise

94. *See infra* Part VI.

95. *See infra* Part VI.

96. *Id*.

97. Peter Csermely et al., *Structure and Dynamics of Core/Periphery Networks*, 1 J. COMPLEX NETWORKS 93, 94 (2013). And, as Figure 2a below suggests, it appears that the Biotech Alliance Network has "scale free" properties, which refers to networks where the distribution of links follow a power law (some nodes have dramatically more links than most others), rather than a normal distribution.

98. *See supra* note 88 and accompanying text.

99. Mark E.J. Newman, *Assortative Mixing in Networks*, 89 PHYSICAL REV. LETTER 208701-1, 2 (2002). For additional influential work on preferential attachment, see Albert-Lazlo Barabasi & Reka Albert, *Emergence of Scaling in Random Networks*, 286 SCIENCE 509 (1999).

notes, these agreements "fall in the large gray area between traditional contractual arrangements and corporate acquisitions."[100] Their central purpose is to structure a joint discovery process by which new technology is created. This means that, at the time the collaboration agreement is executed, the development path for a drug is highly uncertain. Industry participants regularly tell stories of how two partners thought they were going to develop a drug that treated one disease only to find over the course of the collaboration that the drug addressed a different disease.[101] As a result, the substance of these agreements typically "remains to be completed, and often defined, over time."[102] In other words, the parties cannot delineate concrete performance obligations in the agreement, such as those we might expect in a traditional contractual arrangement.

Crucially, that uncertainty also makes it difficult for parties to bargain over who is going to own whatever drug may result from the collaboration. How do you take a negotiating position on a drug when you do not even know what it is going to be? The potential outcomes of a collaboration can be dramatically different. Many projects result in failure as a once promising drug fails clinical trials, but every once in a while a few go on to be blockbuster multi-billion-dollar pharmaceuticals. Therefore, collaboration agreement negotiations are ripe with uncertainty and can be high stakes ventures. As a result, many collaborators end up sharing discoveries. They agree that new technology that relates to both parties' pre-existing intellectual property will be jointly owned.[103] This blurs the boundaries between the assets companies own.

Sharing discoveries has an important practical implication for collaborating partners. Under the default rules of U.S. patent law, a single joint owner can exploit and transfer the jointly owned technology without the consent of the other joint owner.[104] That means, for example, that one partner could license the technology to the competitor of the other partner. This raises the possibility that, absent some contractual limitations on how the joint owners can license the jointly owned intellectual property, one company's valuable technology might spill over into the hands of a third party.

Interviewees consistently identified joint ownership and its potential for spillovers as a concern.[105] They also stated that opportunism problems were not as serious as other exchange hazards affecting alliances. As one interviewee put it, "[o]pportunism problems really only arise in rare situations with an idiosyncratic founder at a small company."[106]

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100. THOMAS F. VILLENEUVE & ROBERT V. GUNDERSON, JR., CORPORATE PARTNERSHIP: STRUCTURING AND NEGOTIATING DOMESTIC AND INTERNATIONAL STRATEGIC ALLIANCES 1–2 (5th ed. 2017).

101. Interview #1.

102. VILLENEUVE, *supra* note 100.

103. Interview #1; Interview #6; Interview #9.

104. 35 U.S.C. § 262 ("In the absence of any agreement to the contrary, each of the joint owners of a patent may make, use, offer to sell, or sell the patented invention within the United States, or important the patented invention into the United States, without the consent of and without accounting to the other owners."); *see generally* Liza Vertinsky, *Boundary-Spanning Collaboration and the Limits of Joint Inventorship Doctrine*, 55 HOUS. L. REV. 401 (2017).

105. The attorneys interviewed tended to focus on spillover problems. Alliance managers confirmed the important role of spillovers but also linked spillover risk to broader challenges the collaborating companies may have in coordinating their joint discovery efforts. As one alliance manager noted, spillovers and coordination problems are interlinked: "Intellectual property problems can interfere with coordination among the alliance partners. If you can't clearly define ownership, then that becomes a roadblock for collaboration." Interview #14.

106. Interview #2; *see also* Interview #1 (noting that hold-up problems are rarely acute in biopharmaceutical alliances due to the relatively modest amounts of capital invested).

D. Formal Contracts Address Collaboration's Spillover Risk

Facing the spillover risks that joint ownership creates, the lawyers advising on these transactions got creative. They devised contractual terms that gave companies tools for limiting spillovers that patent rights could not provide.

Those tools are found in highly complex formal contracts. These agreements often number in the hundreds of pages.[107] They are a far cry from the informal, back-of-a-napkin deals often highlighted in the private ordering literature.

Key parts of collaboration agreements address the spillover problems that greater network connections exacerbate. For an example, consider how Vir Biotechnology, Inc. (Vir), a company engaged in COVID-19 drug development, contractually governs its collaborations.[108] Vir uses a robust formal agreement to govern its alliances. Its agreement with Alnylam, which was originally created to develop and commercialize RNA interference therapeutics for infectious diseases and was later expanded to include Covid-19,[109] includes contract terms that address the risk that information sharing between the parties will lead to the spillover of proprietary technology.[110] First, the agreement allocates control rights between the parties with respect to certain spillover issues.[111] Second, in

107. Practitioners estimated that most alliance contracts in the biopharma industry have terms of 5–10 years. *See* Interview #2 ("Deals are 5–10 years long typically."). Practitioners interviewed for this study repeatedly noted that formal collaboration agreements are heavily negotiated and, as a result, highly customized to each particular deal. Interview #1, Interview #2, Interview #6, Interview #9. For a useful overview of the typical terms of alliance contracts, see VILLENEUVE *supra* note 100.

108. Vir is a relative newcomer to the biopharmaceutical industry, founded in 2017 by Robert Nelson, one of the most successful biopharmaceutical venture capitalists in the world. Arlene Weintraub, *Stealthy Vir Allies with Alnylam and Others to Build Infectious Disease Pipeline*, FIERCEBIOTECH (Oct. 18, 2017, 7:01 AM), https://www.fiercebiotech.com/partnering/stealthy-vir-allies-alnylam-and-others-to-build-infectious-disease-pipeline [https://perma.cc/2G38-FGSR]; Taylor Carmichael, *Why Did the Market Whack This IPO? The stock of Vir Biopharmaceutical lost 30% of its value on its first day of trading*, MOTLEY FOOL (Oct. 14, 2019, 12:11 PM), https://www.fool.com/investing/2019/10/14/why-did-the-market-whack-this-ipo.aspx [https://perma.cc/TW78-53LM]. Vir was created on the idea that the biopharmaceutical techniques being used to develop treatments for cancer could be employed in the fight against infectious diseases. *Id.* Indeed, in the first quarter of 2020, Vir entered into a number of alliances with other companies for the development of COVID-19 drugs. Vir entered into collaboration agreements with Alnylam, Wuxi, Xencor, Biogen, and the National Institute for Health. Jacob Plieth, *Covid-19 Oils the Wheels of Business Development*, EVALUATE VANTAGE (Apr. 7, 2020), https://www.evaluate.com/vantage/articles/news/deals/covid-19-oils-wheels-business-development [https://perma.cc/65UE-GLQA]. In early April, Vir agreed to a collaboration with GlaxoSmithKline for the development of COVID-19 drugs. Josh Nathan-Kazis, *Vir Biotechnology Stock Jumps on Covid-19 Deal With GlaxoSmithKline*, BARRON'S (Apr. 6, 2020, 10:52 AM), https://www.barrons.com/articles/vir-biotechnology-stock-jumps-on-glaxosmithkline-covid-19-deal-51586184765 [https://perma.cc/HY94-V9LK].

109. Press Release, Alnylam, Alnylam and Vir Form Strategic Alliance to Advance RNAi Therapeutics for Infectious Diseases (Oct. 18, 2017), https://www.businesswire.com/news/home/20171018005459/en/Alnylam-Vir-Form-Strategic-Alliance-Advance-RNAi [https://perma.cc/6HUF-SJLV]; Vir Biopharmaceutical, Inc. and Alnylam Pharmaceuticals, Inc., Collaboration and License Agreement by and among Vir Biotechnology, Inc. and Alnylam Pharmaceuticals, Inc. Dated as of October 16, 2017, art. 7.1 [hereinafter Collaboration and License Agreement] [https://perma.cc/8YBP-8A8E]; Press Release, Alnylam, Vir and Alnylam Expand Collaboration to Advance Investigational RNAi Therapeutics Targeting Host Factors for the Treatment of COVID-19 (Apr. 2, 2020), https://investors.alnylam.com/press-release?id=24696 [https://perma.cc/FF3E-FNSK].

110. Collaboration and License Agreement, *supra* note 109.

111. For instance, the contract includes several pages of provisions carefully controlling the sharing of proprietary information between the companies and limiting both Vir's and Alnylam's abilities to undertake projects outside the collaboration's field of research. *Id.* The agreement also provides that, if either Vir or Alnylam acquire rights to a competing product, they must either divest the rights in that product related to the

addition to those discrete control rights, it creates a management committee system in the agreement to harness spillover risks by giving both parties a veto right over decisions that will lead to costly spillovers.

The agreement establishes a Joint Steering Committee and provides for other committees, including a Patent Sub-Committee that oversees the determination of ownership of foreground intellectual property. In addition to facilitating information flow between the parties, those committees also limit the possibility of technology spillovers in an important respect. The consensus-based decision rule that the joint governance committees were required to follow gives each party the ability (1) to steer the collaboration in a direction that will avoid conflicting with other areas of that party's technological portfolio; (2) to veto decisions regarding the definition and prosecution of foreground intellectual property rights that may interfere with other aspects of its technological portfolio; and (3) to veto a counterparty's attempt to transfer jointly-owned foreground intellectual property, which under U.S. law allows a co-owner to license the jointly-owned patent without the permission of the other co-owner.[112] Because every committee in each tier of the administrative structure was bound by the unanimity rule, those veto points were available both at the granular level and at the relationship-spanning level.[113]

Interviews with practitioners at a number of the leading firms advising biotech companies add details on the role governance committees play in these deals. An alliance manager described the role of governance committees as follows:

> *Steering committees are the most important governance tools in the agreement. If issues arise, then they are escalated to the steering committee. On normal days, just alliance managers address problems. When a more complicated issue arises, then it is escalated to the steering committee or even the CEOs, because the companies' ongoing collaboration could be affected. The issues typically escalated to the CEO levels are typically about IP ownership and related regulatory concerns.*[114]

A law firm partner described the role of governance committees as follows:

> *Intellectual property ownership is an important driver for governance*

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collaboration's field of research or include the acquired product within the collaboration's field of research, bringing the product within the remit of the agreement, which then requires the benefits to be shared. *Id.* at § 10.6. Boundaries between solely-owned and jointly-owned foreground intellectual property were established, the agreement carefully allocated options to each party with respect to prosecuting foreground patents, and the parties were allocated rights with respect to enforcing foreground patent rights against alleged third party infringers. *Id.* at §§ 8.1–8.3. Interestingly, each party is given the option to prosecute its counterparty's solely-owned patents where the counterparty elects not to prosecute, a nice illustration of the agreement addressing the situation where a problem arises for Party A from Party B's patent portfolio. *Id.* at § 8.2.

112. *Id.* at § 2.6 (providing that all Joint Steering Committee decisions be made by consensus). Veto rights in many alliance agreements are not absolute. If the representatives on a committee cannot reach an agreement, the dispute is typically escalated to a higher committee, or to senior executives, with dispute resolution in private arbitration or public court as final recourse. Practitioner interviews indicated that escalation is usually quite costly, however, and so the incentives to reach consensus are strong. Interview #3 (noting that teams often do not want to escalate because of "embarrassment of having to go to executives," and because "the cost of dispute resolution is high"); Interview #4 ("One of the main things that make the governance committees work in real life is that nobody wants to escalate this to their boss. They want to resolve it.").

113. Collaboration and License Agreement, *supra* note 109, at § 2.5 (providing that sub-committees will be governed by the same decision-making rules as the Joint Steering Committee).

114. Interview #6.

> *committees. If one party owns all of the foreground intellectual property, then the governance committee is still useful for promoting visibility between the parties. But the committee is particularly critical if there is joint ownership—it is really important in that case. There, the committee is a mechanism for solving questions such as: What is an improvement to my IP alone, and how are we going to manage the rest of the IP that we both control? Where there is an overlap between the two parties' background IP, a sub-committee may be set up to focus on these issues.*[115]

Another described the use of governance committees as follows:

> *Committees, and particularly the IP sub-committee, will be used where there is a concern about overlapping patents among the contracting parties, and where the prosecution of foreground patents is sensitive. An overlap raises the possibility that one party's activities will be considered an improvement on the other party's IP, and the committee will direct the collaboration to avoid or manage those issues if possible.*[116]

One interviewee also noted:

> *Patent sub-committees will be used where there is an overlap between the parties, where the patent landscape is complex, and particularly with large molecules, where the patent filing is more case-specific and, therefore, uncertain.*[117]

In summary, spillovers are addressed through a combination of affirmative control rights coupled with flexible administrative mechanisms, which allow parties to redirect or even stall an alliance's progress when spillover risks loom.

E. More Collaborative Companies Use More Robust Formal Contracts

If formal contract mechanisms, such as governance committees, are used to address the spillover risks that arise from joint ownership, then we would expect those tools to be used more often as spillover risk increases with greater network connectivity. An interviewee provided the following anecdote illustrating the logic:

> *Recently one of our alliance partners asked us if we would have an issue with them doing a related project with another partner. Yes, that's a whole new ball game. They would be giving the other partner materials and intellectual property, and there is an issue about the ownership of the new intellectual*

115. Interview #4.

116. Interview #7. A few interviewees differentiated between the functions served by a steering committee and a patent sub-committee when a multi-committee structure is used. One described the steering committee as an "early warning system for telling you when the science isn't working," differentiating it from the IP-focused patent sub-committee. Interview #4. Another noted that, "When there are multiple committees, the steering committee is more focused upon reducing uncertainty, rather than focusing upon specific issues such as hold-up or an IP leak." Interview #10. Spillover issues are devolved to the IP sub-committee. *Id.* However, the main steering committee will get involved in spillover issues if a dispute is escalated from the patent sub-committee, or if the agreement only has a single steering committee and no sub-committees. *Id.*

117. Interview #11. "Large molecules" refers to the biological drugs, which tend to have a complex molecular structure, developed through biotechnology.

> *property being developed. The alliance manager and the patent subcommittee provided the starting point for sorting this out. We brought additional experts, such as the parties' legal teams, into the deliberations and eventually sorted an arrangement out.*[118]

As parties have more contractual relationships with third parties, the risk of a "whole new ball game" arising increases. In those situations, parties are more likely to include governance committees in their alliance contracts.

A quantitative study of a unique hand-collected dataset of over 600 biopharmaceutical alliance agreements was designed to test whether, indeed, market practice reflected that positive relationship between greater network connections and increased use of governance committees.[119] The study finds evidence that parties with greater network connections use governance committees to govern their alliances more often. The results of the study also allow us to discount some leading alternative explanations.

1. Research Design

The study examines biopharmaceutical companies' use of three formal contract mechanisms. The first is whether at least one general steering committee is used in an alliance. Evidence that these general steering committees are used more often when companies are more connected in the network supports the theory that these committees are used to address spillovers. The second is more specific: whether a sub-committee dedicated to patent issues also appears in the alliance. Evidence that these specific

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118. Interview #16.

119. The data collected for this study fall into two categories. First, data on alliance relationships were collected to construct a map of the biopharma alliance network. Data for the network were primarily collected from Clarivate Analytics' Cortellis database, which compiles alliance data from SEC filings, news accounts, press releases, and submissions from market participants. Those data collected from Cortellis were supplemented with unique data from Thomson Reuters' SDC Platinum Joint Ventures/Strategic Alliances database, and hand-collected data from Bloomberg's and LexisNexis's respective EDGAR Filings databases. To construct the network, all databases were searched for collaboration, co-development, license, joint venture, manufacturing, and research agreements designated as falling within SIC code 2834 between 1995–2015.

Second, a subset of collaboration and co-development transactions in the biopharma alliance network were randomly identified and the formal contracts governing those deals were collected from either Bloomberg Law's or LexisNexis's EDGAR Filings databases. Most of the contracts sampled through this process involve publicly-traded biopharmaceutical firms and pharmaceutical partners. Public companies are required to disclose "material contracts" to the markets, and, while materiality is ultimately decided by the company, agreements amounting to 5% or more of the firm's revenues are usually disclosed. Commercially sensitive language in the agreements that are posted on the SEC's EDGAR database is often redacted, which limits full visibility. Following de-duplication, and the elimination of "miss hits," the relevant details of those contracts were then hand-collected. Hand-collection involved agreements being coded double-blind and subject to a quality control process to ensure consistency. In total, data on 653 agreements were collected.

It is important to note that sampling agreements from the Recap, SDC Platinum, Bloomberg, and LexisNexis databases raises the possibility of selection bias. Successful firms that are able to go public may be overrepresented in the sample—a form of "backward looking bias" affecting many financing and contracting studies. This might mean that exchange hazards may be less acute in the sampled agreements than in the broader population of alliances, since the characteristics of these publicly-traded firms, which are presumably more successful than an average company in the industry, may have been partially observable at the time of contracting, leading to more muted use of formal governance mechanisms. This creates reason for caution when generalizing from the study's results, although, as Lerner and Malmendier note, this form of selection bias only affects the strength of an estimated effect and not its directionality. Josh Lerner & Ulrike Malmendier, *Contractibility and the Design of Research Agreements*, 100 AM. ECON. REV. 214, 225 (2010).

committees are used more often when companies are highly connected is a strong indication that formal agreements are being used to limit spillovers. The third is whether the financing partner in the alliance also acquires an equity stake of the R&D partner. Acquiring an equity stake in the R&D company typically gives the financing company the right to appoint a member of the R&D company's board of directors, which is a formal tool for the financing company to oversee and discipline the R&D company. That formal tool is best suited for addressing company-wide risks, not specific spillovers in a particular transaction. Thus, studying the incidence of equity stakes provides us with an auditing tool. If we see equity stakes also increase with greater network connections, then perhaps the theory that formal governance tools are responding to spillover problems is not accurate.

The study also examines the correlation between those three response variables and the incidence of prior deals between alliance partners. This allows us to test traditional private ordering theory directly. If governance committee use declines in alliances where the parties have dealt with one another before, that suggests they have greater trust and informal sanctions are more potent. By analyzing the correlation between prior deals and the response variables, we can essentially run a "horse race" between the two competing theories.

2. Results

Before examining correlations, descriptive statistics are reported to orient the reader to the data. Table 1 reports how frequently the response variables occur in the sample alliance contracts. Nearly three-fourths of the agreements have at least one governance committee established. A little over one-third have a patent sub-committee. And a little over 40% of the deals include the acquisition of an equity stake in the R&D company by the financing partner.

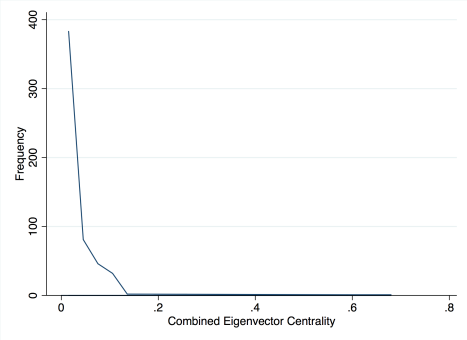
TABLE 1: INCIDENCE OF RESPONSE VARIABLES

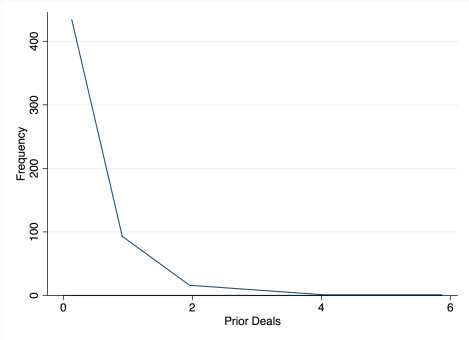
Variable	**Value**	**Percentage**	**Obs.**
At least 1 committee	406	74.5	545
Patent sub-committee	212	38.9	545
Deals where an equity stake is taken	129	41.48	311

We now turn to the study's two explanatory variables. Figure 2a below depicts the distribution of the parties' network "centrality" or the number of connections that companies in the network have.[120] This shows that connections within the network are not evenly distributed—a small number of companies have many connections, but the vast majority of companies have only a few.

120. Centrality in a network can be measured in many different ways, and here eigenvector centrality is used. A colloquial way to understand an eigenvector centrality measure is that, rather than simply tallying the numbers of links a particular node has, as a total degree centrality metric does, a node's centrality is weighted by the centrality of its immediate neighbors, capturing more finely how centrally positioned the given node is. *See* MATTHEW O. JACKSON, SOCIAL AND ECONOMIC NETWORKS 41, 43 (2010).

FIGURES 2A AND 2B: DISTRIBUTION OF CENTRALITY MEASURES AND NUMBER OF PRIOR DEALS IN THE BIOTECH ALLIANCE NETWORK





Prior deals are also unevenly distributed across the sample. Figure 2b above and Table 2 below report the number of alliances in the sample where the parties had a prior deal. Approximately 22% of the alliances had at least one prior deal, although, interestingly, only 3.66% had two or more prior deals.[121] Relationships in the biopharmaceutical network are fleeting.

TABLE 2: NUMBER OF TRANSACTIONS WITH PRIOR DEALS

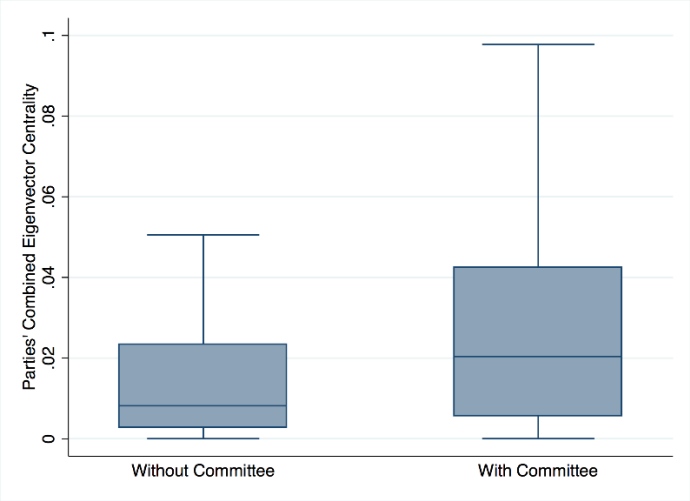
Variable	Value	Percentage	Obs.
Alliances with no prior deals	422	77.29	546
Alliances with a least 1 prior deal	124	22.71	546

Having oriented ourselves to the variables of interest, let's now turn to examining correlations. We will begin with the focal relationship in the study: the correlation between governance committee use and network centrality. Analysis reveals that governance committee use increases as parties' connections in the network grow. Figure 3 below illustrates the correlation. The box plots depict the distribution of parties' network centrality measures for deals with and without governance committees. Alliances that use governance committees involve parties with a higher median network centrality.[122]

121. *See* George P. Baker, Robert Gibbons & Kevin J. Murphy, *Strategic Alliances: Bridges Between "Islands of Conscious Power"*, 22 J. JAPANESE & INT'L ECON. 146, 162 (2008) (finding a similarly low rate of prior deals in their study of biotech collaborations).

122. To measure the different levels of embeddedness for each company, the eigenvector centrality of each node was calculated based on the industry network as it was constituted for the previous three years prior to the data that a given agreement was executed. Eigenvector centrality is a spectral measure that calculates the centrality of a node in a network as a function of the centrality measures of the other nodes to which it is directly connected, and in that respect it captures the difference between being embedded in a thickly interconnected neighborhood and being embedded in a more peripheral one. JACKSON, *supra* note 119, at 40–43. That makes eigenvector centrality typically more accurate than simpler centrality metrics, such as total degree centrality, which is a sum of all of a node's links. In this study, the eigenvector centrality measures of all parties to the agreement were then

FIGURE 3: DISTRIBUTIONS OF PARTIES' COMBINED NETWORK CENTRALITY IN TRANSACTIONS WITH VS. WITHOUT GOVERNANCE COMMITTEES



The relationship between prior deals and governance committee use was also analyzed, but no significant relationship was observed. Parties who had a prior alliance were neither more nor less likely to include a governance committee in their contract. The lack of a correlation between prior deals and governance committees is not what we would expect according to the private ordering literature. However, it is consistent with what practitioners interviewed for this project said. As one interviewee noted: "I wouldn't change the way I drafted a contract based on previous deals between the parties."[123]

Of course, the correlation between network centrality and committee use may be spurious. Perhaps something other than network position explains the pattern that is observed. To address that possibility, a more elaborate test is required.

A logistic regression model analyzing the relationship between both explanatory variables and the three response variables was estimated.[124] That allows us to analyze the correlations while also controlling for other possible explanations.[125] The model includes control variables for a number of deal characteristics and party characteristics that might affect the use of governance committees.[126]

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summed to create a continuous variable, Network Centrality, since the level of embeddedness of all parties affects the ease by which their information diffuses through the industry network.

123. Interview #8; *see also* Interview #2.

124. The response variable—the incidence of a governance committee—is binary, and therefore logit models are specified to test the correlations between the response variable and the explanatory variables. The baseline model estimates the log of the probability that a response variable correlates with the various right-hand side variables: where p indicates the probability of a response variable occurring, and β are the regression coefficients associated with each right-hand side variable.

125. Committee incidence is a binary variable, coded as 1 if there is at least one governance committee established or as 0 if no committee is established.

126. Those controls include: (1) whether the agreement integrated the parties' tasks or kept them separate, as a measure of how closely the parties worked together, which may affect the use of a committee; (2) whether one party licensed background intellectual property to the other on an exclusive basis, and the other only licensed

The results of that analysis are reported in Table 3 below. Results such as those in Table 3 may be unfamiliar for some readers, so a brief orientation is provided here. Across the top of the table are the response variables in which we are interested. In the first column of the table are the explanatory variables of interest and the additional control variables.[127] At the intersection between the rows and the columns is a "marginal effects" figure that describes the relationship between the explanatory and control variables, on one hand, and the formal contract terms, on the other. Marginal effects capture the change in the occurrence of a formal contract term as a function of a change in the explanatory variable, holding other right-hand side variables constant.

To demonstrate, let's look at one of the correlations in which we are interested. In the second column of Table 3, the relationships between explanatory variables and the incidence of at least one governance committee are reported. If you look at the cell where Network Centrality and Governance Committee intersect, you will see the figure 0.319, accompanied by three asterisks. That figure means that a one unit increase in the parties' combined network centrality is associated with a 31.9 percentage point increase in the probability of at least one governance committee being used. Asterisks next to the marginal effects figure indicate whether the relationship between the explanatory variable and the response variable is statistically significant at the 95% (one star), 99% (two stars) or 99.9% (three stars) confidence level. In that regard, the three asterisks beside the marginal effects figure describing the relationships between the parties' network centrality and the use of a governance committee means that it is highly unlikely that the correlation between the two is simply a matter of chance. Figures with no asterisks beside them indicate that the null hypothesis, which states that the relationship between the variables is random, cannot be rejected with confidence.

When we look at the results reported in columns (2) and (3) of Table 3 on page 365 of this Article, we find evidence consistent with the network costs thesis. Parties' combined network centrality and the use of both a governance committee and patent sub-committees are positively correlated and highly significant, even when controlling for deal characteristics and party characteristics. This gives us more comfort that the correlation is not spurious.[128]

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on a non-exclusive basis, as a measure of hold-up risk; (3) whether certain foreground intellectual property would be jointly-owned, as a deal-specific measure of spillover risk; (4) the value of the Volatility Index ("VIX") upon execution of the contract, which measures the stock market's expectation of future volatility and serves as a rough measure of environmental uncertainty; (5) the ratio of upfront to deferred consideration, which captures the amount of bargaining leverage an R&D partner has in an alliance; and (6) whether one of two leading law firms, which have a disproportionate share of the market, advised on the transaction, which roughly captures law firm effects. Party characteristic control variables include: (1) the financing partner's annual revenues for the year the alliance was executed, which is a rough measure of the company's size and, in turn, preference for formal organization; and (2) the R&D company's reported EBITDA for the year the alliance was executed, which is a rough measure of the company's financial health.

127. Together, the explanatory and control variables can be summarized as "right-hand side" variables because they are on the right-hand side of the regression model.

128. One question is whether the results reported here are sensitive to how the combined network centrality measure is calculated. Recall from the discussion above that the eigenvector centrality of each party is calculated and then summed together to create a combined figure. *See supra* notes 121,123, and accompanying text. Might, for instance, the centrality of the financing partner have a more pronounced effect than the R&D partner's centrality?

Two robustness checks were undertaken to address that question. First, in unreported results, identical regression models to those reported in Table 3 were estimated; with the exception that, rather than combining the

parties' centrality measures, the eigenvector centrality of the financing partner and the R&D partner were separately used as an explanatory variable in order to test whether the network position of a particular type of partner is driving the results. Interestingly, both the financing partner's network centrality and the R&D partner's network centrality had a positive and significant correlation with increased committee use and patent sub-committee use. Second, also in unreported results, identical regression models were estimated, except that the parties' combined betweenness centrality, rather than combined eigenvector centrality, was used as an explanatory variable. In this case, the results for all specifications were functionally identical. In summary, the results do not change materially with an alternative approach to network centrality.

TABLE 3: SUMMARY OF RESULTS OF REGRESSION ANALYSES

(1)	(2) Governance Committee	(3) Patent Sub-Committee	(4) Equity Stake Acquired
Prior Deal	0.474	0.171	0.603
	(1.48)	(0.64)	(1.76)
Net. Centrality	0.319***	0.302***	-0.0275
	(4.37)	(4.05)	(-0.37)
VIX	-0.0933	-0.402	0.337
	(-0.29)	(-1.41)	(1.00)
Multistage	0.702*	1.101**	-0.138
	(2.21)	(3.29)	(-0.34)
Task Interdep.	0.660*	0.850**	0.949*
	(2.23)	(3.27)	(2.54)
Asym. Back. IP	-0.308	-0.491*	0.103
	(-1.12)	(-2.08)	(0.36)
Joint Fore. IP	1.174***	0.992***	0.353
	(4.49)	(4.03)	(1.20)
Top 2 Law Firm	1.161*	0.691*	-0.318
	(2.42)	(2.37)	(-0.78)
Milestone Ratio	-0.244	-0.131	0.448*
	(-1.28)	(-0.67)	(2.09)
Fin. Co. Rev.	0.00000209*	0.000000268	0.00000156*
	(2.06)	(0.47)	(2.22)
R&D EBITDA	-0.000600*	-0.000568	-0.000771
	(-2.22)	(-1.78)	(-1.16)
Constant	1.396	-0.0157	-2.593*
	(1.30)	(-0.02)	(-2.26)
N	512	512	292

Note: Reporting marginal effects; standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

There is more going on in the results reported in Table 3, however. First, note that the relationship between prior deals between the parties and the response variables is also estimated. Examining the effect of prior deals on the design of the alliance transactions is undertaken to further test the conventional theory that informal sanctions substitute for formal contracts. Interestingly, the existence of one or more prior deals between alliance partners has no statistically significant relationship to any of the formal contract terms. Having a prior transaction does not correlate with using formal governance tools. The lack of a statistically significant relationship between prior deals and the response variables is inconsistent with conventional wisdom in the private ordering literature.

The study also analyzes an additional formal governance tool—the acquisition of an equity stake in the biotech company by the financing partner—as a way to test the reliability of the findings further. As noted above, when a financing partner, such as a large pharmaceutical company, takes an equity stake in the smaller biotech partner, it typically receives the right to appoint a member of the biotech company's board of directors. That board seat serves as a formal governance tool, but it functions a bit differently than the governance committee in an alliance contract. Both an alliance governance committee and a corporate board are deliberative bodies that provide varying degrees of veto opportunities. However, the alliance committee's purview is restricted to the contractual relationship, while the corporate board of directors monitors all of the biotech company's dealings. In that respect, the alliance committee is a much finer-tuned tool for preventing spillover risk. For that reason, we would not expect to see the acquisition of an equity stake to increase with greater network centrality.

Indeed, as reported in column (4) of Table 3, we find no statistically significant correlations between either network centrality or prior deals and the acquisition of an equity stake by the financing partner in an alliance. This provides additional evidence that is consistent with the network costs thesis—because the firm-level monitoring that an equity stake typically makes available is a not a direct or effective check on specific spillovers, the network costs thesis would not predict a significant relationship.

To summarize, the results in Table 3 indicate that there is a positive relationship between the parties' network centrality and governance committee use. The relationship between the parties' combined network centrality and the use of at least one governance committee or a patent sub-committee structure is positive and statistically significant at the 0.1% level. However, the relationship between the parties' network centrality and the acquisition of an equity stake in the R&D company is not statistically significant. Network centrality appears to correlate with some formal governance tools but not all. Furthermore, the existence of prior deals between the contracting parties has no statistically significant relationship with any of the response variables studied here. Those results are also consistent with the network costs thesis. They suggest that parties more embedded within the industry network may be using formal governance committees more frequently in order to address the spillover costs that rise with greater network centrality.[129]

129. It is worth mentioning another interesting finding identified in the results. The choice of legal advisor, one of the control variables, has a statistically significant relationship with three out of the four response variables. A growing body of contract scholarship examines the effect legal advisors have upon contract design, questioning the assumption in both contract law and contract economics that agreements are pure reflections of the parties' interests and bargaining power. Klausner, *supra* note 74; Klausner & Kahan, *supra* note 74. At least, the transactional lawyers advising on a deal filter and translate those interests in the design process, which may cause some distortion, and, at the extreme, the attorney's own incentives or inertia may interfere with their clients'

There are, of course, limits to this study, which caution against drawing hasty conclusions and which subsequent research will explore in more detail. Most obviously, this is an observational study, which identifies patterns that are unlikely to be explained by chance but cannot support inferences of causality. Also, this study is limited to the biopharmaceutical sector and it is not clear that the lessons drawn here are generalizable to other domains. Furthermore, this study only scratches the surface of the complex governance systems deployed to govern technology alliances. Scores of additional contract terms are used and should be included in subsequent analyses.[130]

F. Summary: Formally Ordered Creativity

The picture that emerges from the biotechnology industry is different from the standard private ordering story. The biotechnology industry has a thick network of connections between companies—the sort of structure that would readily circulate reputational information. However, formal contracting increases as parties become more embedded in the network. Formal governance committees, which are theorized to address spillover problems, are used more frequently when the collaborating companies have greater network centrality. However, other formal governance tools do not correlate significantly with network centrality. Parties are carefully using some formal contract terms (but not all) to address these unique types of exchange risks that differ from classic hold-up.[131]

In turn, the study finds little evidence of extra-legal enforcement such that

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goals. *See generally* MITU GULATI & ROBERT E. SCOTT, THE THREE AND A HALF MINUTE TRANSACTION: BOILERPLATE AND THE LIMITS OF CONTRACT DESIGN (2013). The correlations in Table 5 suggest that the involvement of a leading law firm in an alliance transaction has a similar effect on the design process. Alliances are more likely to have one or more governance committees and to have multiple stages when Cooley or WilmerHale, the two market-leading legal advisors, are involved.

The role of legal advisors in relational contracting is an important but largely overlooked topic. One explanation for that oversight is that the literature on law firm effects on contract design is largely focused upon lawyers' role in standardizing boilerplate contract terms. Relational contracts are typically understood as more customized transactions, and so the boilerplate research may appear irrelevant. The results in Table 5, however, suggest that law firms may still have an effect on contract design even in deals like biotechnology alliances that are highly negotiated. In fact, one way to think of legal advisers' role is in the network terms discussed throughout this article. That is, law firms inhabit an industry network—the market for legal services—that shapes their access to information and incentives, which in turn influences the advice they provide on transactions. A question for future research is to identify with more precision how the structure of the legal services network relates to the design of agreements among companies in an industry network.

130. There are also limits with respect to the study's network analysis. First, the centrality measures used here are drawn from static, rather than dynamic networks. Controlling for year fixed effects addresses the concern that formal governance patterns can be explained as the evolution of "market" terms. But more subtle questions, such as whether a material shift in a company's network position over time affects contract design, have yet to be studied. It is also important to note that this study does not apply concepts of network brokerage. An influential line of scholarship originating in Burt's work argues that centrality measures do not capture situations where a node within a network connects, or brokers, two or more otherwise disconnected components within a network, which provides the node with unique access to information. *See generally* RONALD S. BURT, STRUCTURAL HOLES: THE SOCIAL STRUCTURE OF COMPETITION (2009); Ronald S. Burt, *The Network Structure of Social Capital*, 22 RSCH. ORG. BEHAV. 345 (2000). Relatedly, the study does not analyze differentials between the alliance partners' network positions, which may also affect their governance strategies.

131. In that respect, it appears that parties carefully address different risks with different parts of the alliance contract. This is consistent with the argument that contracts are "multivalent" tools for addressing a variety of exchange hazards. Jennejohn, *supra* note 28.

biotechnology collaborators operate with only minimal reliance on the legal system.[132] The results certainly do not support the traditional substitutionary view of the relationship between formal and informal enforcement. No statistically significant negative correlation between either network centrality or prior deals and a formal governance mechanism is found. This is consistent with interviewee comments. As a management consultant who was interviewed said, "Reputations exist and matter somewhat. But reputations depend upon who is running the company, and that can change. Reputational issues are not a big deal that keeps people from doing transactions."[133] Or as another interviewee put it, "There are limits to what you can do with reputational information—it doesn't affect how you contract."[134]

One counterargument to this Article's theory is that the results above are actually consistent with a different theory of extra-legal enforcement. According to that alternative interpretation, we would expect governance committees to be used more frequently because greater network centrality imposes stronger reputational constraints on the parties, which makes them less likely to abuse formal governance mechanisms.[135] In other words, this view sees the formal contract itself as a possible way to hold-up one's counterparty, by dishonestly alleging a breach of the agreement and tying them up in litigation.[136] In that case, reputational sanctions arising from the industry network may constrain that opportunistic abuse of the formal agreement. For instance, Bernstein's recent study of heavy equipment manufacturers in the U.S. Midwest provides evidence that highly-connected original equipment manufacturers ("OEMs") are more likely to have unilateral termination rights in their contracts with suppliers because those suppliers know that, if the OEM abuses the termination right, it will be informally punished by the many other suppliers with which it has relationships.[137] By extension, this argument suggests that we see more frequent use of governance committees because stronger reputational sanctions more credibly police any potential abuse of the formal terms of the contract.

That alternative explanation struggles to explain the biopharmaceutical experience in a number of ways. First, according to that theory, one would expect the incidence of prior deals between the parties to also correlate positively and significantly with governance committee incidence, but we find no such evidence. Second, under this alternative theory, we would also expect other formal governance mechanisms, such as the acquisition of an equity stake in the R&D company, to increase significantly with greater network centrality. We find no such evidence, however.[138] Relatedly, in unreported regression results, an analysis of the correlation between the financing partner's network centrality and the incidence of a unilateral termination right for the financing partner—the formal contract term Bernstein focused upon—found no statistically significant relationship between the two. Third, none of the practitioners interviewed for this project agreed that reputational constraints made parties more willing to include formal contract terms, such as governance

132. Bernstein, *Beyond Relational Contract*, *supra* note 15, at 563.

133. Interview #5.

134. Interview #4.

135. Bernstein, *Beyond Relational Contracts*, *supra* note 15.

136. Klein, *Why Hold-Ups Occur*, *supra* note 37, at 448.

137. Bernstein, *Beyond Relational Contracts, supra* note 15, at 563–65.

138. *See supra* Table 3. (demonstrating the statistical insignificance of acquiring an equity stake in an R&D company).

committees, in their agreements.[139]

In summary, networks matter. But *how* they matter differs from the conventional wisdom. In large, diverse, and dynamic networks like in biotechnology, the conventional relationship between network and formal contract is reversed. Networks exacerbate spillover risks, and so formal contract terms are used to address that problem. Instead of networks governing contractual relationships, contracts may be used to address exchange risks that networks exacerbate.

IV. CREATIVE ORDERING FOR PUBLIC PURPOSE

What each gains by his secrecy is less, in many cases, than what he might gain by a liberal policy of give and take with his associates.[140]

—Alfred Marshall, *Industry and Trade*, 1919

The evidence presented in Part II above suggests that the biopharmaceutical industry does not privately order the joint development of new drugs. Rather, it uses formal legal institutions to govern commercial relationships. Law is not a peripheral institution in the biopharmaceutical industry. Instead, law is central.

Crucially, law's importance does not arise from the lack of a rich industry network, as prior scholarship has assumed.[141] Instead, it is the very robustness of the network that makes law so important. Law is needed to address the problems that the network creates.

This Part of the Article sketches the normative implications of re-centering law in the economy. The goal here is to briefly introduce these new avenues, providing a starting point for later work.

Two settings are focused upon. First, this Part discusses what creative ordering means for contract law. It argues that the evidence of creative ordering here undercuts arguments, rooted in private ordering theory, that the legal system interferes with the efficient operation of commerce. In markets like biopharmaceuticals, there is no private ordering, in the traditional sense, with which to interfere. In fact, to encourage courts to minimize their intervention in contractual relationships, such as by using textualist interpretive doctrines, is to withdraw the very support that commercial parties crave. Creative ordering needs the legal system.

Relatedly, creative ordering expands the social benefits of spillovers as a normative concern for contract law to consider. The empirical analysis in Part II reveals the lengths commercial parties will go to limit spillovers. Is it beneficial for broader society, however, to aggressively limit spillovers as parties wish? The quote that opens this Part, taken from Marshall's classic study of industrial districts, and confirmed in a large body of subsequent research, is that clusters of innovative companies thrive when technical information freely circulates within the market.[142] How far should we allow contract law to restrict spillovers and potentially undercut these clusters? This is a question much discussed in intellectual property policy, and has earned some attention in scholarship on employment contracting,

139. Interviews #2, #3, #4, #9, #10; *see also supra* notes 133–34 and accompanying text.

140. MARSHALL, *supra* note 25, at 583.

141. Zasu, *supra* note 24.

142. *See* Ellison et al., *supra* note 25; Greenstone et al., *supra* note 25 (examining agglomeration spillovers).

but it has yet to be addressed as a central concern in contract theory. Creative ordering moves it to center stage.

The second setting is economic policy, rather than the legal system itself. This Article reveals an important new role for law in the modern economy. Creative ordering is not only a tool for private parties to govern joint discover but also one for the administrative state to stimulate development.

Years of widening inequality, punctuated by two recent economic crises, have brought the U.S. policy establishment to the brink of a new consensus that was unimaginable just a decade ago. For the first time in over a generation, industrial policy is on the table.[143] Both major U.S. political parties are calling for state investment in important industries at levels reminiscent of the Second World War and the Cold War race to the moon.[144]

Creative ordering is the vehicle by which that industrial policy is executed. Consider, for example, the U.S. federal government's and the European Union's impromptu industrial policies for developing COVID-19 vaccines. Contracts that bear an uncanny resemblance to the private agreements analyzed in Part II above were used to foster vaccine innovation.

This raises the important question of how creatively ordered agreements should be calibrated to support broad-based economic development. That is, the normative question is not the traditional question of how law should support private contracting, but rather how private contracting should explicitly be put to public use. This opens an entirely new avenue for policy and research. Contract design is no longer of tangential interest to the administrative state, but is a crucial, if easily overlooked, aspect of 21st century economic policy.

A. Contract Law for a Creatively Ordered Economy

Calibrating the legal system to support creatively ordered markets requires two steps. First, the private ordering literature's counterproductive normative arguments for

143. Karl Aiginger & Dani Rodrik, *Rebirth of Industrial Policy and an Agenda for the Twenty-First Century*, 20 J. INDUS. COMPETITION & TRADE 189–207 (2020). For earlier work, see Dani Rodrik, *Normalizing Industrial Policy* (Commission on Growth and Development Working Paper, No. 3, 2008), https://openknowledge.worldbank.org/handle/10986/28009 [https://perma.cc/7P9A-DR28]; Dani Rodrik, *Industrial Policy for the Twenty-First Century* (Sept. 2004), https://papers.ssrn.com/abstract=617544 [https://perma.cc/8BLL-HZKQ].

144. *Compare* President-Elect Joe Biden, Speech on COVID-19 Economic Recovery Plan (Jan. 14, 2021), https://www.rev.com/blog/transcripts/joe-biden-speech-transcript-on-covid-19-economic-recovery-plan [https://perma.cc/8ENQ-RTT4]; *The Biden Plan to Ensure the Future is "Made in All of America" by All of America's Workers*, BIDEN HARRIS: DEMOCRATS, https://joebiden.com/made-in-america/ [https://perma.cc/48FX-987D] ("U.S. manufacturing was the arsenal of democracy in World War II . . . It will be so again. . . . Imagine historic investments in research and development to sharpen America's innovative edge in markets where global leadership is up for grabs, markets like battery technology, artificial intelligence, biotechnology, clean energy.") *with* Senator Marco Rubio, Speech on American Industrial Policy and the Rise of China, Speech at U.S. National Defense University (Dec. 10, 2019), https://americanmind.org/memo/american-industrial-policy-and-the-rise-of-china [https://perma.cc/9KH2-N4RN]; *see also* Chairman Marco Rubio, *Introduction to* PROJECT FOR STRONG LABOR MARKETS AND NATIONAL DEVELOPMENT, MADE IN CHINA 2025 AND THE FUTURE OF AMERICAN INDUSTRY, 4, 5 (2020), https://www.rubio.senate.gov/public/_cache/files/0acec42a-d4a8-43bd-8608-a3482371f494/262B39A37119D9DCFE023B907F54BF03.02.12.19-final-sbc-project-mic-2025-report.pdf [https://perma.cc/7TCM-JWTF] ("Lately, success . . . has been defined by the growth of financial services instead of applied research or advanced manufacturing. The conclusion we should draw from this evidence is that we have too often failed to make the well-being of working Americans the terms for market success.").

minimalistic contract enforcement should be rejected. Second, contract law must start expressly contending with the question of how the enforcement of contractual obligations in an expanded variety of settings affects spillovers, which are harmful to individual companies but often socially beneficial. Those two issues are discussed here in turn.

B. Against Universal Legal Minimalism

This Article's first normative claim is that courts adjudicating disputes where spillovers are at issue should ignore the private ordering literature's calls for minimalistic enforcement.

It is important to note that the basis for that claim is different from prior understandings of private ordering's limits. Private ordering scholarship has tended to view the limits of extra-legal sanctions as coterminous with the limits of exchange networks. For instance, in some markets, exchange networks may be so fragmented or thin that reputational information does not circulate, and deals may repeat so rarely that bilateral sanctions are weak.[145] From this perspective, the extent of the network in a market determines the limits of extra-legal sanctions. Other research argues that informal sanctions may rely upon social norms that are not necessarily efficient.[146] Coordination problems between market participants, who settle on a sub-optimal norm, define the limits of extra-legal sanctions.[147] Finally, other scholarship has argued that reputational sanctions may police flagrant breaches of contractual obligations, but they do not capture low-level cheating that commonly occurs.[148] From this perspective, the inability of a social network to circulate certain types of information established the limits of extra-legal sanctions.

In all of those perspectives, informal sanctions would operate *if only the network worked better*. If only there were more connections between parties in the market. If only parties could coordinate within the network more efficiently to identify the best informal rules. If only information about small-scale grifting travelled as well as scandalous frauds.

Conversely, in markets where networks are robust and informal sanctions are available, the private ordering literature argues that formal legal institutions should defer to those extra-legal sanctions.[149] Courts should apply minimalistic doctrines, such as a hard parol evidence rule and textualist interpretation, to avoid interfering with informal governance.[150] Furthermore, if claims that private ordering is widespread across the entire modern economy, then legal minimalism should be universally applied.[151]

This Article identifies a fundamentally different type of limit to information sanctions. Spillover risk does not arise from fragmented networks, from a lack of coordination between parties, or from the inefficient transfer of information. In fact, the problem is precisely the opposite. The better information diffuses in the network, the worse the problem grows. The network is its own worst enemy.

That new type of limit means that exchange networks present a trade-off for parties.

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145. *Braiding*, *supra* note 16.

146. *See* Richard H. McAdams & Eric B. Rasmusen, *Norms and the Law*, *in* 2 HANDBOOK L. & ECON. 1573, 1593 (A. Michell Polinsky & Steven Shavell eds., 2007) (noting that social norms are not always efficient norms).

147. *See generally* BRIAN SKYRMS, THE STAG HUNT AND THE EVOLUTION OF SOCIAL STRUCTURE (2003).

148. *See generally* Emily Kadens, *Cheating Pays*, 119 COLUM. L. REV. 527 (2019) (stating that "reputational sanctions will incentivize parties to play honest[ly]").

149. *See supra* note 3 and accompanying text.

150. Bernstein, *supra* note 4.

151. *See supra* note 58.

Networks may support informal governance, but they may also exacerbate spillover risks. Blanket statements that formal law only interferes with privately ordered deals are no longer fully accurate. Rather, in markets where spillover risks are material, parties use formal agreements to carefully balance the costs and benefits of networks.[152] In those circumstances, private ordering scholarship's rationale for protecting informal sanctions through minimalist, textualist intervention by public courts ignores the important ways parties rely upon formal legal institutions to address spillovers.

At the same time, it would be a mistake to use this Article as the basis for an equally sweeping claim that a minimalistic approach to contract enforcement should be uniformly rejected. Rather, what this study suggests is that markets are heterogeneous. In some markets, such as wholesale commodities, the spillover costs that exchange networks pose are de minimis. In others, like biopharmaceuticals, they are serious. Informal sanctions may be effective in one, formal legal institutions may be critically important in another. The idea that a single enforcement regime would govern both is wishful thinking. A one-size-fits-all enforcement approach is inappropriate. Rather, we need a diverse range of institutions that can fit the specific circumstances of a given innovation network.[153]

C. Creative Ordering and an Expanded Purpose for Contract Law

This Article's second normative contribution is that the costs and benefits of spillovers should be included as an additional normative dimension to be addressed in debates over the appropriate scope of judicial intervention in contract disputes. Even if contractual parties wish for the legal system to assist them in their effort to limit spillovers, as this Article has demonstrated, there is a follow-on question of whether it is socially beneficial for courts to do so.[154]

This normative issue is the subject of a large debate in intellectual property policy[155] and has already been raised in the employment context, where non-compete agreements arguably chill innovation by limiting the diffusion of information.[156] This Article suggests, however, that spillover concerns in contract are not just isolated to non-compete agreements. Rather, spillover concerns are more broadly implicated whenever creative ordering occurs. For instance, the interpretation and enforcement of the formal contracts that creatively order innovation processes can affect the likelihood of spillovers. As an example, consider a dispute between Affymax NV and Johnson & Johnson, parties to a research collaboration, that arose when Johnson & Johnson sought patents to foreground

152. Gilson, Sabel & Scott also envision a role for formal agreements in highly innovative markets, primarily as tools for addressing opportunism. *See* Gilson et al., *Contracting for Innovation*, *supra* note 16. The role of formal agreements here is quite different: Instead of dealing with opportunism, creative ordering addresses spillover issues. Jennejohn, *The Private Order of Innovation Networks*, *supra* note 16.

153. The possibility of non-unitary market infrastructure is broached in an important paper by Gilson, Sabel, and Scott. *See* Ronald J. Gilson et al., *Text and Context: Contract Interpretation as Contract Design*, 100 CORNELL L. REV. 23 (2014). In my prior work, I raise the possibility of using network structure as a means to calibrate different parts of legal infrastructure for different markets. *See Braided Agreements*, *supra* note 16.

154. Considering the benefits of third-party spillovers may well lead courts to a style of enforcement minimalism. The grounds for such minimalism differ, however, from the private ordering literature's rationale for minimalism, and the precise doctrines where such minimalism may be pursued will likely differ also.

155. *Supra* note 26.

156. *Supra* note 27.

intellectual property listing only its scientists as inventors.[157] Under the terms of the Affymax/J&J collaboration agreement, each party would solely own any technology that it developed alone, and they would jointly own any new technology that they created together.[158] Affymax sued Johnson & Johnson to establish its joint ownership. It did not do so idly—the disputed foreground IP was a key input for a drug Affymax was planning on commercializing with a different partner.[159] When a court interprets and enforces the provisions of a collaboration agreement like Affymax and Johnson & Johnson's, it directly manages the spillover of information in the market.

This gives courts a new role in markets. In this position, courts manage spillovers within the exchange network, operating somewhat like a standard setting organization or patent pool that manages the coordination and sharing of information in an industry.[160] That is, when the modular boundaries of property become blurred,[161] an organizational response—in this case in the form of *ex post* adjudication rather than an *ex ante* collective rights organization—is used to manage information.[162] How courts should fulfill this role is an important new question for future research to focus upon.

D. Creative Ordering in the New Industrial Policy

The Article's third implication arises in an entirely different setting: Economic policy. Creative ordering plays an important role in the new industrial policy that is emerging in the United States and elsewhere. It is the tool the administrative uses to stimulate innovation.

As mentioned above, industrial policy, long thought a dead letter in the United States,

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157. Affymax, Inc. v. Johnson & Johnson, 420 F. Supp. 2d 876, 877–78 (N.D. Ill. 2006).

158. Affymax, Inc. v. Johnson & Johnson, No. 1:04-cv-06216 (Nov. 23, 2010) (Exhibit 2, Research and Development Agreements. 4.1).

159. Press Release, Fierce Biotech, Affymax and Janssen Biotech Settle Patent Dispute (Nov. 9, 2011), https://www.fiercebiotech.com/biotech/affymax-and-janssen-biotech-settle-patent-dispute [https://perma.cc/ZAS5-PEYB].

160. Those institutions facilitate broad access to enabling technology by requiring members of the organization to license their technology to one another on a "fair, reasonable, and non-discriminatory" or "FRAND," basis. Jorge L. Contreras, *A Brief History of FRAND: Analyzing Current Debates in Standard Setting and Antitrust through a Historical Lens*, 80 ANTITRUST L.J. 39, 45 (2015).

161. Smith, *supra* note 26.

162. *See generally* Henry E. Smith, *Property as Platform: Coordinating Standards for Technological Innovation*, 9 J. COMPETITION L. & ECON. 1057 (2013). While patent pools are widely used in some industries, such as consumer electronics, they have not been widely used in biotechnology, however. That may be changing as the complexity of the patent landscape in biotechnology increases. Consider, for example, "CRISPR" technology, a new foundational gene-editing technology to which multiple universities and companies have competing patent claims. *See* Jorge L. Contreras & Jacob S. Sherkow, *CRISPR, Surrogate Licensing, and Scientific Discovery*, 355 SCIENCE 698, 698 (2017). As a general counsel interviewed for this project noted:

> The industry is going to move toward patent pooling. CRISPR is a great example. Everyone's guess is that [the universities and companies litigating over ownership of CRISPR technology] will have to cross-license eventually. As the patent landscape gets more and more crowded, then the pharmaceutical industry is going to have to adopt something similar to electronics.

Interview #11. In fact, a number of CRISPR patent holders, including MIT and Harvard, contributed 22 of their patents to a patent pool in 2017 in an effort to streamline the licensing process. Aggie Mika, *Major CRISPR Patent-Holders Agree to Patent Pool*, SCIENTIST (Jul. 10, 2017), https://www.the-scientist.com/the-nutshell/major-crispr-patent-holders-agree-to-patent-pool-31267 [https://perma.cc/R2NY-9XMU].

is experiencing a revival.[163] What is less clear is the form this new industrial policy should take. Most commentators reject the industrial policy of the mid-20th century of the state "picking winners" in an industry.[164] Primarily, calls are for industrial policy in the form of contractual public-private partnerships.[165]

This is where creative ordering steps in. Creative ordering provides the framework for those contractual public-private partnerships. As an example, consider the strategies of both the U.S. federal government and the European Union for COVID-19 vaccine development, which illustrate creative ordering's new role.

The COVID-19 global public health crisis has presented society with an innovation problem as difficult as it is urgent. Combating the outbreak has required the rushed development of diagnostic tools to identify accurately those infected with the virus and treatments that increase the likelihood of survival, such as ventilators, or limit contagion, such as masks. The key challenge, however, has been developing an effective vaccine that will stop the pandemic in its tracks, a monumental task.[166]

Contracts have been central to the development of a COVID-19 vaccine.[167] The U.S. federal government and the European Union support the vaccine development process primarily through formal agreements. Neither government has the internal scientific capacity to develop an effective vaccine, and so it must rely upon the private sector for development. Of course, neither government blindly writes checks to private companies,

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163. *See supra* notes 143 and 144 and accompanying text (noting the return of explicit industrial policy to mainstream American political discourse).

164. Aiginger and Rodrik, *supra* note 143.

165. *Id*. Both President Biden's and Senator Marco Rubio's proposals also focus on contractual mechanisms for stimulating investment. Biden, *supra* note 144; Rubio, *supra* note 144.

166. *See*, *e.g*., Seth Berkley, *Coronavirus Shows How We Need Vaccines Before, Not After, An Outbreak*, FORTUNE (Feb. 29, 2020, 7:00 AM), https://fortune.com/2020/02/29/coronavirus-covid-19-flu-vaccine/ [https://perma.cc/A3FR-J34X] (discussing how proactive vaccine development efforts can curtail future outbreaks). Early reporting attributes delays in the development of COVID-19 vaccines to deficient planning and execution by the Trump Administration. *See* Eric Lipton et al., *He Could Have Seen What Was Coming: Behind Trump's Failure on the Virus*, N. Y. TIMES (Apr. 11, 2020), https://www.nytimes.com/2020/04/11/us/politics/coronavirus-trump-response.html [https://perma.cc/5CPM-NCBZ]; Yasmeen Abutaleb et al., *The U.S. was Beset by Denial and Dysfunction as the Coronavirus Raged*, WASH. POST (Apr. 4, 2020), https://www.washingtonpost.com/national-security/2020/04/04/coronavirus-government-dysfunction/ [https://perma.cc/DZA9-DJ96]; Aaron Blake, *2 Months in the Dark: The Increasingly Damning Timeline of Trump's Coronavirus Response*, WASH. POST (Apr. 8, 2020), https://www.washingtonpost.com/politics/2020/04/07/timeline-trumps-coronavirus-response-is-increasingly-damning/ [https://perma.cc/UT7P-M8LS].

The typical drug development timeline spans several years—the recent development of an Ebola vaccine in just five years is considered quite rapid, for instance. Ben Hargreaves, *The Journey to An Approved Ebola Vaccine*, BIOPHARMA REP. (Nov. 19, 2019, 13:19 GMT), https://www.biopharma-reporter.com/Article/2019/11/15/A-timeline-of-Ebola-vaccine-development [https://perma.cc/XT7F-DVZH]. For further details on the collaboration between academia and industry that led to the Ebola vaccine, see Helen Branswell, *'Against All Odds': The Inside Story of How Scientists Across Three Continents Produced an Ebola Vaccine*, STAT (Jan. 7, 2020), https://www.statnews.com/2020/01/07/inside-story-scientists-produced-world-first-ebola-vaccine/ [https://perma.cc/R6NZ-CR8S] (discussing the interactions between researchers and pharmaceutical companies in creating and mass-producing vaccines). For a global pandemic killing hundreds of thousands and leaving a devastated economy in its wake, that traditional timeline is unacceptable.

167. For a helpful discussion that situates contractual collaboration within the broader institutional ecosystem of COVID-19 vaccine development, see Ana Santos Rutschman, *The COVID-19 Vaccine Race: Intellectual Property, Collaboration(s), Nationalism and Misinformation*, 64 WASH. U. J.L. POL'Y 167 (2021) (analyzing a variety of factors that contribute to vaccine development through the lens of development of the COVID-19 vaccine).

no strings attached.[168] Rather, they use contracts to determine what the private companies will do in return for the funding they receive.[169] Contracts are the foundation upon which COVID-19 vaccine development is built.

The contracts used to support COVID-19 vaccine development bear an uncanny resemblance to the private agreements studied in Part II above. To illustrate, consider the contracts used by the U.S. federal government.[170]

The primary agency in the U.S. responsible for organizing rapid vaccine development is the Biomedical Advanced Research and Development Authority ("BARDA"), which is part of the Department of Health and Human Services.[171] Formed in 2006, BARDA is occasionally referred to as the federal government's biopharmaceutical venture capital firm, because of its role in financing early drug research and development.[172]

For its financing arrangements, BARDA often uses an obscurely named type of contract called an "Other Transaction."[173] The unusual moniker only makes sense in the broader context of government procurement contracting. Other Transactions are legal instruments that fall outside of the Federal Acquisition Regulation ("FAR"), which usually applies to most government contracts.[174] Contracting under "Other Transaction Authority"[175] rather than the FAR is preferable because doing so gives BARDA much more flexibility to design agreements that are tailored to the needs of a development project, without complying with the mandatory rules of the FAR.[176]

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168. At least, we hope the federal government does not act so blindly, although decisions by the Trump administration often called the basis for such hope into question. *See*, *e.g.*, Kyle Blankenship, *Kodak's $765 Million Manufacturing Loan on the Rocks as Red Flags Multiply*, FIERCE PHARMA (Aug. 10, 2020, 8:09 AM), https://www.fiercepharma.com/manufacturing/kodak-s-765m-manufacturing-loan-rocks-as-federal-investigations-mount [https://www.fiercepharma.com/manufacturing/kodak-s-765m-manufacturing-loan-rocks-as-federal-investigations-mount] (discussing the corruption concerns that have arisen around the large manufacturing contract Eastman Kodak secured in July 2020 to help produce a COVID-19 vaccine—Kodak had no prior experience in drug manufacturing).

169. *See infra* Part IV.B.

170. The European Union's agreements are highly similar. *See*, *e.g.*, Press Release, European Commission, IP/21/302, Vaccines: Contract between European Commission and AstraZeneca Now Published (Jan. 29, 2021), https://ec.europa.eu/commission/presscorner/detail/en/IP_21_302 [https://perma.cc/6MM2-C8JF]; Advance Purchase Agreement for the Production, Purchase, and Supply of a Covid-19 Vaccine for the European Member States, European Union-CureVac, June 18, 2020, C(2020) 4192, https://ec.europa.eu/info/sites/info/files/curevac_-_redacted_advance_purchase_agreement_0.pdf [https://perma.cc/WPA4-5JK2].

171. The Department of Defense has also funded at least one Other Transaction related to COVID-19 vaccine development. KEI Briefing Note at 14.

172. Dan Gorenstein, *BARDA: The Venture Capital Firm Buried in the U.S. Government*, MARKETPLACE (Oct. 30, 2014), https://www.marketplace.org/2014/10/30/barda-venture-capital-firm-buried-us-government/ [https://perma.cc/GXX3-3P9Z].

173. BARDA's first Other Transaction was a 2013 agreement with GlaxoSmithKline for the development of drugs to counter bioterrorism. *See* Press Release, U.S. Dep't of Health and Hum. Servs. News Div., HHS Forms Strategic Alliance to Develop New Antibiotics Approach Provides a Pipeline of New Drugs Rather Than a Single Medical Countermeasure (May 22, 2013), https://www.phe.gov/Preparedness/news/Pages/strategic-alliance-130522.aspx [https://perma.cc/JW6G-RKP8].

174. Red River Waste Sol., Inc., B-414367, 2017 CPD ¶ 97 (Comp. Gen. Mar. 21, 2017) ("[A]greements issued by the agency under its 'other transaction' authority 'are not procurement contracts.").

175. NASA was the first Executive Branch agency to receive Other Transaction Authority. National Aeronautics and Space Act of 1958, Pub. L. No. 85-568, §203(b)(5), 72 Stat. 426, 430 (1958). The Department of Health and Human Services received authorization in 1972. Pub. L. No. 92-423, § 3, 86 Stat. 679, 680 (1972).

176. OTA agreements are used typically in research & development situations, where the flexibility of the OTA process can expedite negotiations and, at times, entice bidders who do not typically engage in government

BARDA uses that Other Transaction Authority to design agreements that closely resemble the private sector agreements studied in Part II above.[177] For instance, they include a high-level initial research plan, a governance committee subject to a unanimity decision rule, a consideration mechanism by which BARDA provides financing to the private company, a license to relevant background intellectual property, intellectual property ownership provisions that apply to the foreground technology created during the relationship, and termination provisions.[178] BARDA's Other Transactions are essentially the public sector versions of the agreements that have been used for decades in the biopharmaceutical industry.

These agreements govern all of the major vaccine development projects the U.S. federal government has funded. BARDA has used its Other Transaction Authority to enter into collaborations with at least six private companies, including Johnson & Johnson,[179] Sanofi,[180] Regeneron,[181] Genentech,[182] AstraZeneca,[183] and Moderna,[184] for the

procurement due to the FAR's heavy regulatory burden. Armani Vadiee & Todd M. Garland, *The Federal Government's "Other Transaction Authority*," 18-5 BRIEFING PAPERS 1 (2018), https://acquisitioninnovation.darpa.mil/docs/Articles/Briefing%20papers%20THE%20FEDERAL%20GOVERNMENTS%20OTHER%20TRANSACTION%20AUTHORITY.pdf [https://perma.cc/K33P-8EWK].

177. BARDA's template for Other Transactions can be found at https://www.phe.gov/about/amcg/otar/Pages/default.aspx [https://perma.cc/RSK4-H3BT].

178. Press Release, Johnson & Johnson, Johnson & Johnson Announces Collaboration with U.S. Department of Health & Human Services to Accelerate Development of a Potential Novel Coronavirus Vaccine (Feb. 11, 2020), https://www.jnj.com/johnson-johnson-announces-collaboration-with-u-s-department-of-health-human-services-to-accelerate-development-of-a-potential-novel-coronavirus-vaccine [https://perma.cc/P4K9-K7PF]. For reference, the reader is encouraged to compare BARDA's agreements with the contracts analyzed in Part III.D above.

179. Other Transaction for Advanced Research (OTAR) between Janssen Research & Development, LLC and the U.S. Dep't of Health and Hum. Servs. Biomedical Advanced Rsch. and Dev. Auth., Agreement No. HHSO100201800012C (Sept. 21, 2018) (on file with author). This 2018 agreement between Janssen, a subsidiary of Johnson & Johnson, and BARDA was amended multiple times in 2020 to include COVID-19 vaccine development. *See* Amendment of Other Transaction Agreement (OTA) Other Transaction Agreement for Advanced Research (OTAR) between Janssen Research & Development LLC and the U.S. Dep't of Health and Hum. Servs. Biomedical Advanced Rsch. and Dev. Auth. Concerning Influenza Portfolio and Other Emerging Pathogens Development Candidates, Agreement No. HHSO100201700018C Amendment No. 0006 (Feb. 11, 2020); *Id.*, Agreement No. HHSO100201700018C Amendment No. 0007 (Mar. 20, 2020); *Id.*, Agreement No. HHSO100201700018C Amendment No. 0008 (Mar. 27, 2020) (all on file with author).

180. The agreement with Sanofi is through its subsidiary, Protein Services Corp. *See* Order for Supplies or Services, Contract No. HHSO100201600005I, ASPR-BARDA and Protein Services Corporation (Feb. 14, 2020); Order for Supplies or Services, Contract No. HHSO100201600005I, ASPR-BARDA and Protein Services Corporation (Feb. 7, 2020) (both on file with author).

181. Other Transaction Agreement (OTA) Other Transaction for Advanced Research (OTAR) between Regeneron Pharmaceuticals, Inc. and the U.S. Dep't of Health and Hum. Servs. Assistant Sec'y for Preparedness and Response, Agreement No. HHSO100201700020C (Jan. 31, 2020) (on file with author).

182. Other Transaction Agreement (OTA) Other Transaction for Advanced Research (OTAR) between Genentech, Inc. and the U.S. Dep't of Health and Hum. Servs. Assistant Sec'y for Preparedness and Response Concerning Genentech Umbrella Agreement, Agreement No. HHSO100201800036C (Sept. 27, 2018) (on file with author).

183. U.S. Dep't of Health and Hum. Servs. Off. of the Assistant Sec'y for Preparedness and Response, *Trump Administration's Operation Warp Speed Accelerates AstraZeneca COVID-19 Vaccine to be Available Beginning in October* (May 21, 2020), https://www.hhs.gov/about/news/2020/05/21/trump-administration-accelerates-astrazeneca-covid-19-vaccine-to-be-available-beginning-in-october.html [https://perma.cc/A4A6-ZR95].

184. Award/Contract No. 75A50120C00034, ASPR-BARDA and Modernatx, Inc. (Feb. 14, 2020) (on file with author).

development of COVID-19 vaccines.[185] BARDA has also entered into similar agreements with biopharmaceutical companies for the development of COVID-19 treatments and drug manufacturing capacity.[186]

The use of creative ordering in contemporary industrial policy raises a critical new question for policy and research that until now has been entirely overlooked: How should creative ordering be calibrated to best advance industrial policy's goals? Discrete questions for future research to consider include:

- What contractual mechanisms should Other Transaction Agreements include to incentivize knowledge sharing among a cluster of innovative companies?
- What contractual mechanisms should Other Transaction Agreements include to incentivize rapid development?
- How does government ownership, including jointly with private parties, of foreground intellectual property affect innovation incentives?
- How should internal contracting capacity within BARDA and other agencies be developed to optimize the design of Other Transactions?
- How and when should the contractual innovations developed in the context of Other Transaction Agreements be transplanted in other aspects of government procurement governed by the FAR?
- What new contractual mechanisms might be developed to enhance transparency within public-private partnerships?
- How should contractual mechanisms differ across industries to address unique combinations and intensities of exchange hazards?
- How should creatively ordered industrial policy interact with more traditional policy exercised through the Defense Production Act?
- How should the policy experimentation made possible through contractual public-private partnerships inform the federal government's overarching industrial strategy?

Tackling those questions is, of course, outside the scope of this paper. However, a brief, high-level assessment of BARDA's vaccine development contracts might provide us with a sense of the potential we might unlock if research and policy attention is focused on this issue.

Consider, for example, the question of whether BARDA can use creative ordering to

185. The Department of Defense also has an agreement that appears to be an Other Transaction for the development of a COVID-19 vaccine with Ology Bioservices, Inc. *See* 10 USC 2373 Agreement Between Ology Bioservices, Inc. (Awardee or Contractor) and Natick Contracting Division (Government), Agreement No. W911QY-20-9-0003 (Feb. 21, 2020) (on file with author). The Ology Bioservices OTA is not identified as an OTA in its title, but is identified as an Other Transaction on FPDS.gov. *See* https://ghiaa.org/wp-content/uploads/2021/06/ology-bioservices-therapeutic.pdf [https://perma.cc/2U5W-DL6M].

186. Searching the federal government's procurement database, FPDS.gov, for contracts with the COVID-19 National Interest Action code and then further filtering the search for agreements with the AN13 PCS Category, which applies to pharmaceutical development, and the Department of Health and Human Services as the Awarding Agency results in 34 agreements.

expand the number of companies collaborating on vaccine development. Broader collaboration may increase the speed and quality of development. How might the design of BARDA's agreements achieve that goal?

There are no legal impediments to expanding Other Transactions to multiple parties. Other Transaction Authority is used frequently by some agencies, such as the Department of Defense, to govern consortia involving multiple companies.[187] The basic legal foundation for multilateral collaboration already exists.

Since Other Transaction Authority can readily accommodate multilateral collaborations, the only remaining task is to entice private companies to participate. Short of directly commandeering production through the Defense Production Act, BARDA has two transactional tools at its fingertips for accomplishing this. One can be considered a "carrot," and the other a "stick."

The carrot BARDA could use is a contractual device known as contingent consideration in its Other Transactions. In most biopharmaceutical collaborations, the consideration that the financing partner provides the R&D partner is divided between an upfront payment, milestone payments, and royalties.[188] Milestone payments are the contingent aspect: A tranche of the financing is only released to the R&D company if a milestone is achieved.[189] In most deals, clearing regulatory hurdles, such as clinical trials, are the milestones on which payments are conditioned.[190]

Using a milestone payment system, particularly one that is tied to an aggressive timeline, would reward biopharmaceutical companies for collaborating more broadly. If the timeline is tight enough, and assuming the rewards for success are substantial, then it is more likely that biopharmaceutical companies will have to work together to achieve the milestones. Furthermore, milestones in biopharmaceutical research are relatively easy to administer,[191] and, crucially, milestone compensation scales effortlessly as a consortium grows, unlike cost sharing mechanisms.

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187. Vadiee & Garland, *supra* note 176, at 8. As of the summer of 2020, the Department of Defense had 29 multi-party consortia under active management. *Existing Other Transaction (OT) Consortia,* AIDA (July 8, 2020), https://aida.mitre.org/ota/existing-ota-consortia/ [https://perma.cc/HCM4-7C5B] (listing 29 consortia within the Department of Defense and its branches).

188. Crama, de Reyck, and Degraeve provide a formal model that provides insight on how to balance these milestone payments and royalties. Pascale Crama, Bert de Reyck & Zeger Degraeve, *Milestone Payments or Royalties? Contract Design for R&D Licensing*, 56 OPERATIONS RSCH. 1539, 1539 (2008). Milestone payments are also often referred to as "earnouts" or "earnout payments." *Id.*

189. Mark Edwards, *Milestone Payments in Biopharma: Negotiating an Equitable Value Allocation*, NATURE: BIOPHARMA DEALMAKERS (Mar. 29, 2019), https://www.nature.com/articles/d43747-020-00675-3 [https://perma.cc/7RMX-M6JY].

190. *Id*. Other types of milestones are possible, however. For instance, it is possible to link milestones to a particular timeline: NASA's Other Transaction with SpaceX for the development of launch vehicles tied milestones to a specific schedule. GOV'T ACCOUNTABILITY OFF., GAO-09-618, *NASA: Commercial Partners are Making Progress, but Face Aggressive Schedules to Demonstrate Critical Space Station Cargo Transport Capabilities* 20 (2009), https://www.gao.gov/assets/300/291011.pdf [https://perma.cc/2GA4-7WML].

191. Earnouts in many other contexts often lead to contentious litigation, particularly where milestones are rather subjective. *See* Airborne Health, Inc. v. Squid Soap, LP, C.A. No. 4410 VCL (Del. Ch. Nov. 23, 2009). Linking earnout milestones to regulatory approvals puts the determination of whether milestones are accomplished in the hands of a neutral third party. *See* Andrew Jolly & Hemita Sumanasuriya, *A Bridge Over Troubled Water? Key Tips and Traps for Earn-Outs in International M&A* (Mar. 30, 2021), https://my.slaughterandmay.com/insights/client-publications/key-tips-and-traps-for-earn-outs-in-international-m-and-a.

The stick BARDA could use to incentivize multilateral collaboration is a set of onerous licensing terms that private parties could avoid if they agreed to collaborate more broadly. As the starting point for negotiations, BARDA would propose default terms for patent ownership of foreground intellectual property that are purposefully designed to be unattractive to the private companies with which it is negotiating. BARDA could, for instance, insist upon the public receiving the ownership rights that it is owed under statute. If BARDA were to agree to relax those patent ownership terms, then it would be in a position to insist that the companies receiving financing expand the financing arrangement to a multilateral consortium. In that respect, the license acts like a stick, rather than a carrot, that goads industry toward broader collaboration.[192]

Again, the point of this discussion is not to provide an exhaustive critique of BARDA's contracting strategy, a topic reserved for subsequent work. Rather, the idea here is to simply illustrate how focusing policy and research attention on contract design promises to make an important contribution to economic policy. Creative ordering is the tool the state uses to stimulate innovation—indeed, because innovative targets are uncertain at the time of finding, creative ordering is the mechanism by which the state and private sector discover technological possibilities. In that respect, contract design is not tangential but rather the heart of the endeavor.

V. CONCLUSION

This Article began with the story of Hans Thijs, a 16th century Dutch merchant who relied on his social network, among other institutions, to enforce contractual obligations when he traded goods in far-away towns. Thijs' story is just one example of a highly influential theory that reputational sanctions are often used in trading communities to informally enforce contractual obligations. Commerce is "privately ordered," and disputes are settled without going to the state's courts.

Recent research argues that the reach of such informal enforcement is available in the large, dynamic markets of the modern economy. Social networks effectively circulate

192. In an important recent paper, Garcia refers to this type of license as a "penalty default license." Kristelia A. Garcia, *Penalty Default Licenses: A Case for Uncertainty*, 89 N.Y.U. L. REV. 1117, 1118 (2014). The U.S. federal government has the ability to impose a penalty default license upon biopharmaceutical companies. In the U.S., authority exists in the form of "march-in rights" under the Bayh-Dole Act or 28 U.S.C. § 1498. *See* Hannah Brennan et al., *A Prescription for Excessive Drug Pricing: Leveraging Government Patent Use for Health*, 18 YALE J. L. & TECH. 275, 279 n.17 (2017); Valerie Bauman, *Government May Have Ownership or Rights to Coronavirus Vaccines*, BLOOMBERG (Mar. 20, 2020), https://news.bloomberglaw.com/pharma-and-life-sciences/government-may-have-ownership-or-rights-to-coronavirus-vaccines [https://perma.cc/H49L-5J5B]; Adam Houldsworth, *COVID-19 Emergency May Expose Compulsory Licensing Limits*, IAM (Mar. 24, 2020), https://www.iam-media.com/coronavirus/covid-19-emergency-may-expose-compulsory-licensing-limits [https://perma.cc/QS86-CZ4M]. March-in rights under the Bay-Dole Act have never been invoked, and § 1498 has not been used by the federal government to acquire pharmaceuticals since the Vietnam War. *See* Jorge Contreras, *Patents and Coronavirus—Compulsory Licensing, Government Use and March-In Rights*, INFOJUSTICE (Mar. 28, 2020), http://infojustice.org/archives/42184 [https://perma.cc/79ZN-U4VB]; Brennan et al., *supra* note 197 at 298–06; *see generally* MILTON SILVERMAN & PHILIP R. LEE, PILLS, PROFITS, AND POLITICS (1974). Threats in 2001, however, by the Department of Health and Human Services to impose a statutory license on Bayer for Cipro, an anti-anthrax drug, are credited with Bayer dropping the drug's price by half. *See* Jill Carroll & Aaron Winslow, *Bayer to Slash by Nearly Half Price U.S. Pays for Anthrax Drug*, WALL ST. J. (Oct. 25, 2001), https://www.wsj.com/articles/SB1003966074330899280 [https://perma.cc/S7FR-QMKL].

reputational information at great distances and among many participants in the market. In short, the benefits of the private ordering that Hans Thijs used are available to the global markets of the modern economy.

This Article challenges that theory and updates it for the industrial clusters of the 21st century. In a detailed study of the biopharmaceutical alliance network, it finds little evidence of parties relying upon reputational sanctions. Rather, biopharmaceutical companies engage in peripatetic collaboration with partners far and wide, resulting in a diverse and highly dynamic network. Those network connections are not unalloyed benefits but can also present costs to contracting parties. Greater connections increase the likelihood that valuable technical information will spill over to third parties, including competitors. The Article then introduces a new role for formal agreements in relational transactions. Formal contracts are used to directly address those network-based risks. This Article supports that argument with the results of the first empirical analysis in legal scholarship of contracting within a comprehensive industry network. Little evidence supporting the claim that networks govern relational contracts is found; rather, the preliminary analysis suggests that formal agreements are designed to address the costs that network structure exacerbates. The Article refers to this use of formal contracts as "creative ordering," to differentiate it from private ordering and to highlight the innovative context in which it is used.

Finally, this Article introduces creative ordering's normative implications, not only for the legal system but also emergent industrial policy. This discussion of policy implications is not idle musing. Collaborative innovation within a network of trading partners is the rule, rather than the exception, in the modern economy. Teams of scientists, engineers, and entrepreneurs have largely supplanted the heroic solo inventor as the engine of innovation in the United States. As the complexity of technology has increased, so have clusters of creative companies collaborating on new inventions.[193]

At the same time, this collaborative form of economic organization is increasingly vulnerable. Poor management of the pressures to jointly innovate can lead to catastrophic failures, such as the deaths caused by Boeing's poorly co-developed 787 Max.[194] Missteps like that can accumulate, causing innovation networks to atrophy as the failures of individual relationships begin to pile up. As the engine of growth stalls, the bottom can fall out from an entire community. We need look no further than what is often referred to as the American Rust Belt—the remnants of once thriving manufacturing clusters in the Northeast and upper Midwest—for a timely example of the social costs of network

193. In much of the 20th century, innovation was often organized within the boundaries of a single company—classic R&D operations such as Lockheed's Skunk Works were within the control of a sole Chandlerian firm. *See generally* ALFRED D. CHANDLER, JR., THE VISIBLE HAND: THE MANAGERIAL REVOLUTION IN AMERICAN BUSINESS (1977). In recent years, however, firms have increasingly collaborated with one another in order to access expertise and technology they could not otherwise develop internally. *See* Kathleen M. Eisenhardt & Claudia Bird Schoonhoven, *Resource-Based View of Strategic Alliance Formation: Strategic and Social Effects in Entrepreneurial Firms*, 7 ORG. SCI. 136, 136 (1996) ("[A]lliances form when firms are in vulnerable strategic positions either because they are competing in emergent or highly competitive industries or because they are attempting pioneering technical strategies."); 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).

194. *See*, *e.g.*, Peter Robison, *Boeing's 737 Max Software Outsourced to $9-an-Hour Engineers*, BLOOMBERG (June 28, 2019, 4:46 PM), https://www.bloomberg.com/news/articles/2019-06-28/boeing-s-737-max-software-outsourced-to-9-an-hour-engineers [https://perma.cc/UP4K-S7GP].

failure.[195]

VI. APPENDIX

The qualitative portion of this study involved semi-structured interviews with 19 practitioners with extensive experience with biopharmaceutical alliances.[196] Those individuals fell within a variety of roles, including law firm partners, general counsel, management consultants, and alliance managers. A number of the interviewees had multiple roles over their careers—for instance, serving as both a law firm partner and an in-house general counsel. A list of the interviewees, their roles, and the dates of the interviews follow in Table 4 below.

The semi-structured interviews began with the same set of open-ended questions. Additional follow-up questions specific to the interview were also asked to elicit as many insights as possible. Notes of the interviews were kept in real time. All practitioners were granted anonymity so that they could be as forthcoming as possible.

In addition to the interviews reported here, larger team meetings at major law firms were also held. These meetings provided an opportunity to sense check findings among a wider group of experts. The Article does not report the input from these meetings, but it nevertheless informed the project as it progressed.

To identify interview participants, major and minor organizations (law firms,

195. *See* ASHEIM ET AL., ADVANCED INTRODUCTION TO REGIONAL INNOVATION SYSTEMS 1 (2019) ("History shows that these [beneficial networking] patterns can also change over time. The decline of some former growth regions and industrial heartlands like Detroit or the Ruhr area, where the gradual loss of innovation and adaptation capacities culminated in industrial restructuring, crises, and severe socio-economic problems . . . testify to these dynamics.").

196. For additional discussion of this interview method and broader questions of causal inference in qualitative research, see HENRY E. BRADY & DAVID COLLIER, RETHINKING SOCIAL INQUIRY: DIVERSE TOOLS, SHARED STANDARDS (2010); James Mahoney, *Strategies of Causal Inference in Small-N Analysis*, 28 SOCIO. METHODS & RSCH. 387 (2000).

companies, and consultancies) involved in the biopharmaceutical industry were identified using the network data derived from the Clarivate Analytics database. Those data allow one to identify, for instance, the leading law firms advising on biopharmaceutical alliances and the companies with the most alliance experience. Interviews were then solicited from both major and minor organizations in an attempt to capture a variety of perspectives.

TABLE 4: ANONYMIZED LIST OF INTERVIEWEES

Number	Date	Interviewee
1	8-Mar-17	Former partner at law firm
2	23-Oct-17	Partner at consultancy
3	17-Jan-18	Former partner at law firm
4	6-Aug-18	Former partner at law firm
5	17-Sep-18	Partner at law firm
6	14-Dec-18	Partner at law firm
7	18-Dec-18	Partner at law firm
8	19-Jun-19	Former government contracting officer
9	18-Nov-19	Partner at law firm
10	9-Dec-19	Partner at law firm
11	9-Dec-19	Partner at law firm
12	9-Dec-19	Partner at law firm
13	9-Dec-19	Partner at law firm
14	20-Dec-19	General counsel at biopharmaceutical company
15	30-Nov-20	Alliance manager at biopharmaceutical company
16	4-Dec-20	Alliance manager at biopharmaceutical company
17	4-Dec-20	Alliance manager at biopharmaceutical company
18	10-Dec-20	Alliance manager at biopharmaceutical company
19	21-Dec-20	Government contracting attorney

Table 3 in Part II.E above summarizes regression results for the quantitative portion of the empirical study. The three tables that follow below report those same results but in greater detail. Table 5 reports correlations for the use of at least one governance committee and the right-hand side variables of interest. Table 6 reports correlations for the use of a specific patent sub-committee. Table 7 reports correlations for the acquisition of an equity stake in the R&D company by the financing partner. A discussion of the results and their implications is found in Part II.E above.

TABLE 5: RESULTS OF LOGISTIC REGRESSION ANALYSIS OF MARGINAL EFFECTS OF EXPLANATORY VARIABLES ON GOVERNANCE COMMITTEE USE

	Governance Committee		
	(1)	(2)	(3)
Prior Deal	0.418	0.471	0.474
	(1.51)	(1.55)	(1.48)
Net. Centrality	0.265***	0.261***	0.319***
	(4.43)	(3.87)	(4.37)
VIX		0.0264	-0.0933
		(0.07)	(-0.29)
Multistage		0.806*	0.702*
		(2.51)	(2.21)
Task Interdep.		0.851**	0.660*
		(2.87)	(2.23)
Asym. Back. IP		-0.144	-0.308
		(-0.55)	(-1.12)
Joint Fore. IP		0.959***	1.174***
		(3.79)	(4.49)
Top 2 Law Firm		1.027*	1.161*
		(2.21)	(2.42)
Milestone Ratio			-0.244
			(-1.28)
Fin. Co. Rev.			0.00000209*
			(2.06)
R&D EBITDA			-0.000600*
			(-2.22)
Constant	0.261***	0.651**	1.396
	(0.05)	(0.19)	(1.30)
N	544	511	512

Note: Reporting marginal effects; Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TABLE 6: RESULTS OF LOGISTIC REGRESSION ANALYSIS OF MARGINAL EFFECTS OF EXPLANATORY VARIABLES ON PATENT SUB-COMMITTEE USE

	Patent Sub-Committee		
	(1)	(2)	(3)
Prior Deal	0.0666	0.0641	0.171
	(0.30)	(0.26)	(0.64)
Net. Centrality	0.318***	0.273***	0.302***
	(4.93)	(3.87)	(4.05)
VIX		-0.205	-0.402
		(-0.67)	(-1.41)
Multistage		0.858*	1.101**
		(2.57)	(3.29)
Task Interdep.		0.825**	0.850**
		(3.19)	(3.27)
Asym. Back. IP		-0.278	-0.491*
		(-1.24)	(-2.08)
Joint Fore. IP		0.981***	0.992***
		(4.07)	(4.03)
Top 2 Law Firm		0.607*	0.691*
		(2.15)	(2.37)
Milestone Ratio			-0.131
			(-0.67)
Fin. Co. Rev.			0.000000268
			(0.47)
R&D EBITDA			-0.000568
			(-1.78)
Constant	0.208***	0.428*	-0.0157
	(0.04)	(0.19)	(-0.02)
N	544	506	512

Note: Reporting marginal effects; standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TABLE 7: RESULTS OF LOGISTIC REGRESSION ANALYSIS OF MARGINAL EFFECTS OF EXPLANATORY VARIABLES ON ACQUISITIONS OF EQUITY STAKES

	Equity Stake Acquired		
	(1)	(2)	(3)
Prior Deal	0.091	0.83	0.618
	(0.07)	(0.07)	(0.33)
Net. Centrality	-0.003	-0.003	-0.023
	(0.02)	(0.01)	(0.07)
VIX		0.040	0.353
		(0.03)	(0.34)
Task Interdep.		0.134	0.896***
		(0.10)	(0.31)
Asym. Back. IP		-0.007	0.084
		(0.04)	(0.28)
Joint Fore. IP		0.024	0.348
		(0.04)	(0.29)
Top 2 Law Firm		-0.014	-0.378
		(0.06)	(0.43)
Milestone Ratio			0.475
			(0.25)
Fin. Co. Rev.			0.000002**
			(0.00)
R&D EBITDA			-0.0009
			(0.00)
Constant	0.532***	0.808***	-0.394**
	(0.08)	(0.17)	(0.13)
N	310	291	292

Note: Reporting marginal effects; standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$