

# THE TRANSACTIONAL DYNAMICS OF MARKET FRAGILITY

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## I

### INTRODUCTION

One way to frame the post-Cold War era of U.S. economic history is as a revolution in contract design. If the vertically integrated company was the hallmark of the mid-twentieth century economy, then complex contractual arrangements are the essence of early twenty-first century economic organization. Contractual innovation underpins everything from the rise of private equity to the financial products that precipitated the 2008 financial crisis.

Contract's revolutionary role has not, however, been isolated to Wall Street. The less glamorous world of procurement has also undergone a similar transformation. The time where the modal procurement transaction involved a routine call, to be later memorialized in a purchase order, by a purchasing manager at a large conglomerate to the sales office at a supplier to request a shipment of commodity parts is a largely distant memory.

Supply relationships are less unidimensional now. Before, a significant amount of production was handled in-house at the vertically integrated manufacturer, and so procurement was rather straightforward, limited largely to raw materials or other commodities. That changed as growing global product market competition caught producers between demands for faster technological innovation and rapid cost reduction. Many producers responded by “de-verticalizing.”<sup>1</sup> Mid-century corporate monoliths simultaneously shed subsidiaries, exiting the internal production of sub-systems, and expanded their contractual relationships with suppliers. Replacing internal production with contractual relationships gave producers both greater access to technological innovation and flexibility. Instead of developing a product internally, one could buy it from a third-party supplier fully invested in innovating in their area. And, if the development relationship did not work out, then the supplier could, more or less, be replaced. As a result, vast and carefully articulated supply chains grew.

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1. Matthew C. Jennejohn, *Collaboration, Innovation, and Contract Design*, 14 STAN. J. L. BUS. & FIN. 83, 91 (2009); see generally Ronald J. Gilson, Charles Sabel & Robert E. Scott, *Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration*, 109 COLUM. L. REV. 431 (2009); Jonathan C. Lipson, *Promising Justice: Contract (as) Social Responsibility*, 2019 WIS. L. REV. 1109 (2019).

The thousands of suppliers, sub-suppliers, and sub-sub-suppliers from all corners of the world developing systems for Boeing's commercial airplanes are a canonical example.

Shifting production to contractual relationships introduces new types of risk, however. Just as new contractual innovations brought us the financial products that fueled crisis a little over a decade ago,<sup>2</sup> the contractual remaking of modern supply chains has resulted in profound social costs.

We experienced particularly tragic versions of those costs as COVID-19 closed production facilities around the world in early 2020. As the supply of key components was disrupted, lifesaving items, such as masks and other protective materials, were scarce. Disruptions spread across the exchange networks on which modern life relies, amplifying the consequence of outbreaks in different localities. In a word, the distributed markets of twenty-first century capitalism can be extremely "fragile," in the sense that they are systemically sensitive to disturbances.

Proposals for improving market resilience fall into a number of categories. Economic commentary has focused upon re-verticalizing production within firms and, relatedly, re-shoring production within national boundaries. Others argue that public lending—ad hoc versions of which were deployed during the pandemic to shore up struggling companies—should play a larger role. Appetite on both sides of the U.S. bipartisan divide for industrial policy has been renewed, a possibility all but unthinkable a decade ago.

Potential solutions may also be found within the institution on which modern production networks are built: contracting. For instance, an array of longstanding excusal doctrines in Anglo-American contract law—impossibility, impracticability, and frustration of purpose—might also play a role here. *Force majeure* provisions, which parallel the law's default excuse doctrines, are also relevant. Perhaps legal institutions might operate as a distributed system for relieving the financial distress that arises when disruptions ripple along a supply chain.

Which of those policy options should we pursue? One of the challenges of calibrating prescriptions for improving market resilience is accurately diagnosing market fragility. We have a general notion that shocks propagate through exchange networks, but the details of diffusion are elusive. For instance, what determines when a shock is likely to have a widespread impact on a production network? When will the effect of a shock be more isolated? Answering those important questions would allow us to more clearly understand the strengths and weaknesses of the policy and doctrinal proposals currently under consideration, and to appreciate how they may work together—or at cross-purposes.

This Article takes a step toward more clearly diagnosing market fragility for the purpose of developing better policy choices that anticipate and address future crises. It does so by connecting two erstwhile and distinct literatures: the legal

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2. Jonathan C. Lipson, *Re: Defining Securitization*, 85 S. CAL. L. REV. 1229, 1229–30 (2012).

scholarship on relational contracting and the social science on the diffusion of shocks in economic networks. This Article attempts to connect the strategies parties pursue in designing their agreements—a familiar topic to contract scholars—to the diffusion patterns observed in disrupted markets—an increasingly important area of study in macroeconomics. By investigating that intersection, this Article introduces a new potential policy domain for remediating market fragility: Contract design.

To summarize, Part II of this Article reviews the fundamentals of networks and how they are studied. Part III discusses recent research on the scale of private ordering and the potential costs of contractual networks. Part IV argues that two choices that commercial parties make while designing a transaction affect diffusion patterns. First, the network of exchanges in which a shock diffuses reflects market participants' choices of contracting partners. Whom one chooses to deal with, and their relative position in the network, can have important social consequences. Second, investing in bilateral governance, such as by choosing a relational contract rather than a discrete arm's-length arrangement for a supply relationship,<sup>3</sup> can act like a shock absorber for disruptions in a market.<sup>4</sup> In that respect, the flexibility of relational contracting, typically understood in terms of the pros and cons it presents in the bilateral context of an agreement, may also have broader social benefits.<sup>5</sup> Part IV also describes how the choice between arm's-length and relational contracting in turn affects who parties choose to partner with. In that respect, the details of transaction design are critical for a complete understanding of the origins of market fragility.

The Article concludes in Part V by reflecting upon potential implications for policy. Two initial lessons are drawn. First, although market contagion is an externality, and as such a natural subject for regulatory intervention, it presents a wickedly complicated landscape for a regulator to navigate. Although further empirical research is necessary to deepen our understanding of shock propagation in a variety of exchange networks, it is clear enough that any policy response must engage with a diversity of diffusion patterns that may be difficult to anticipate. Market fragility is not uniform across the economy, and so any policy response must be contingent and flexible. Second, given that complexity,

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3. Of course, one of the key teachings of prior contracts scholarship is that nearly all deals are relational in some respect. See Ian R. Macneil, *Contracts: Adjustment of Long-Term Economic Relations under Classical, Neoclassical, and Relational Contract Law*, 72 NW. U. L. REV. 854, 855 (1977–1978) (expanding on “highly relational patterns” in contract law). The degree to which agreements are relational does, nevertheless, often differ across transactions and markets more broadly, with some being more discrete and others more relationally embedded.

4. The argument that contract design can affect the propagation of distress in a market is similar in spirit to the argument advanced by Kathryn Judge, though the supply chain context focused upon here is different than the financial markets central to Judge's study. See Kathryn Judge, *Fragmentation Nodes: A Study in Financial Innovation, Complexity, and Systemic Risk*, 64 STAN. L. REV. 657 (2012).

5. Relational contracting is the subject of a massive literature spanning a number of adjacent disciplines. For an excellent review of the scholarship, which highlights the costs and benefits of relational contracting, see Juliet P. Kostriksy, *A Paradigm Shift in Comparative Institutional Governance: The Role of Contract in Business Relationships and Cost/Benefit Analysis*, 2021 WIS. L. REV. 385 (2021).

improving contract design might be a useful *ex ante* prophylactic measure that promotes resilience in environments where *ex post* regulatory intervention may struggle to gain purchase.

## II

### FROM DESIGNING DEALS TO NETWORK EMERGENCE

While it is natural to refer to the contractual relationships underpinning the production of many contemporary products as supply chains, it is more accurate to think of them as supply *networks*. Much production is more interwoven than a simple chain analogy captures. It may help then, at the outset, to establish some common concepts used to study networks.<sup>6</sup>

#### A. Network Fundamentals

Economic networks emerge from interactions among participants in a market over time.<sup>7</sup> Those interactions may take a variety of forms, from individuals having jobs at an organization to stockholders owning shares of a company to the supply chains focused upon here. Of course, in many cases, different types of interactions overlap—participants in a market may have not only trading connections between one another but also social relationships.<sup>8</sup> The interactions of primary interest in the supply chains here are contractual connections, which arise as consideration is exchanged and risks allocated between parties to an agreement. Those contracts are the primary conduits by which a shock—such as the outbreak of a pandemic, a factory fire, an earthquake, et cetera—spreads in a market. A shock interferes with a supplier’s performance, that supplier breaches its contractual obligations to a buyer, that in turn leads the buyer to breach on its contractual commitments to the customers to whom it sells, and so on.

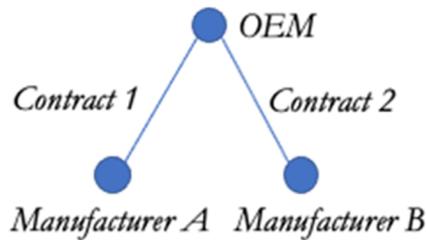
In the parlance of network analysis, contracting parties are the vertices or “nodes” of an exchange network. And the agreements they enter into are the edges or “links” that connect those nodes. As one party executes a contract with another party, a simple network emerges. For instance, imagine that a large original equipment manufacturer (OEM) enters into manufacturing agreements with two upstream suppliers for the production of a sub-system. This simple example could reflect contracts Ford Motor Company has with suppliers. The simple network that results is visualized in Figure 1 below:

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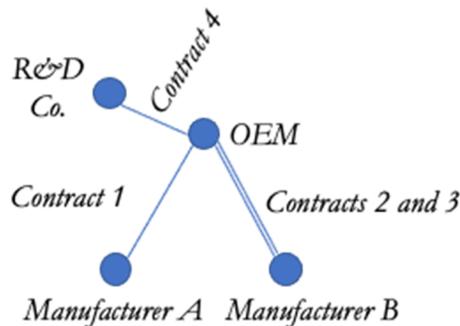
6. This is not meant to be a complete primer, but rather a brief introduction. For an excellent treatment of network fundamentals, see generally MATTHEW O. JACKSON, *SOCIAL AND ECONOMIC NETWORKS* (2008).

7. See generally JOHN F. PADGETT & WALTER W. POWELL, *THE EMERGENCE OF ORGANIZATIONS AND MARKETS* (2012).

8. See, e.g., John F. Padgett, *Transposition and Refunctionality: The Birth of Partnership Systems in Renaissance Florence*, in *THE EMERGENCE OF ORGANIZATIONS AND MARKETS* 171 (John F. Padgett & Walter W. Powell eds., 2012) (analyzing economic, kinship, and political ties among the renaissance Florentine finance elite).

**Figure 1: Illustrative Diagram of Hypothetical Contractual Network**

As time passes, that simple network can grow more complex. For instance, imagine that the OEM signs a second deal with Manufacturer B and enters into a licensing deal with a company that specializes in research & development. The updated network is reflected in Figure 2 below.

**Figure 2: Illustrative Diagram of Network Emergence**

And so on. As contractual relationships accrue over time, that simple network can grow quite large.

As one might imagine, the massive global markets of the twenty-first century can lead to the emergence of enormous networks. One of the industries where we can see such scale is the biopharmaceutical industry, for which publicly available data on contractual relationships is readily available, unlike many other sectors.<sup>9</sup>

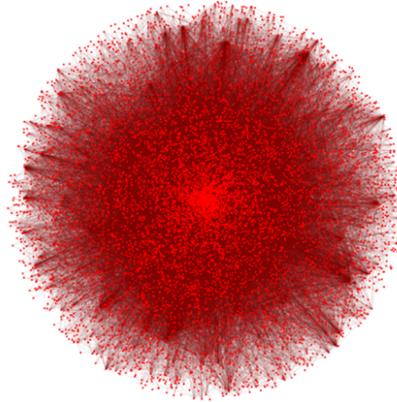
The contractual network that has emerged in biopharmaceuticals is massive.<sup>10</sup>

9. Public data on biopharmaceutical contractual relationships is by no means complete. However, a significant amount of visibility can be achieved because many biopharmaceutical companies file their material contracts with the U.S. Securities and Exchange Commission as part of their reporting requirements as publicly traded companies. Because even small biopharmaceutical companies are often publicly traded, contracts that large companies might deem immaterial are nevertheless disclosed—because they are material to a smaller entity. The upshot is that thousands of R&D agreements, supply agreements, M&A agreements, and financing agreements are publicly available in the biopharmaceutical industry, while only a fraction of contracts can be found publicly in other sectors.

10. See, e.g., Walter W. Powell, Douglas R. White, Kenneth W. Koput & Jason Owen-Smith, *Network Dynamics and Field Evolution: The Growth of Interorganizational Collaboration in the Life*

Figure 3 below depicts the global network of contractual relationships in the biopharmaceutical industry from 1995 through 2015.<sup>11</sup> Over 32,000 contracts (the links in the network), involving over 15,000 parties (the nodes in the network), are captured in the graph.<sup>12</sup>

**Figure 3: Biopharmaceutical Contractual Network, 1996–2015**



### B. Studying Network Topology

Having identified the nodes and links of the biopharmaceutical network, we can then study the characteristics of its structure or “topology.” This can be analogized to studying a map that provides information about the topological characteristics of a certain geography.

The first thing one might do with a topological map is find the location of a place of interest—a town, a campsite, or a landmark, for instance. We can do the same with a network. That is, we can study the relative positions of any given node within the network. For example, a common metric is calculating a node’s “centrality.”<sup>13</sup> The idea can be intuited from Figure 3 above: Links in the

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*Sciences*, 110 AM. J. SOC. 1132, 1157 (2005) [hereinafter Powell et al., *Network Dynamics and Field Evolution*] (analyzing contractual connections in the biopharmaceutical industry); 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) [hereinafter Powell et al., *Interorganizational Collaboration*] (describing the biotechnology industry’s “large-scale reliance on interorganizational collaborations”).

11. This data is more thoroughly analyzed in Matthew Jennejohn, *Do Networks Govern Contracts?*, J. CORP. L. (forthcoming 2022).

12. 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.

13. There are an abundance of centrality measures available in network analysis. Perhaps the simplest is total degree centrality, which simply tallies the number of links for each node in a network—nodes with more links have greater total degree centrality. For further discussion of other common centrality measures, see JACKSON, *supra* note 6, at 37–43.

biopharmaceutical network are not uniformly distributed among nodes, and thus some companies in the network are more central—they have more links—while others are more peripheral—they have fewer links. Incidentally, Pfizer has the most contractual connections in the network with 2,360 links to other companies.

Second, we may want to study the relationship between two, or more, places of interest. We may want to find a path from a campsite to a landmark, for instance. We can also do this with a network. Quite literally, we can trace the path between any two nodes, and we can analyze the qualities of any given link within the network. As an example, links can be directed to reflect the flow of goods or the allocation of risk from one party to another. Or they may be weighted to reflect the number of contracts between two companies, since deals often repeat between participants in many markets. Or we might differentiate links between, say, arm's-length contracts and more relational contracts that interweave two companies. For instance, if the contracts depicted in Figure 2 above follow the typical trends in the biopharmaceutical industry, the agreements between the OEM and Manufacturers A and B will have some relational elements to them but generally be more discrete than the more collaborative arrangement between the OEM and the R&D company.<sup>14</sup>

Finally, we may want to study the overall characteristics of the geographic region we are interested in—its changes in elevation or the grouping of particular things such as a forest of trees or suburbs around a city. Again, we can do this also with networks by characterizing their overarching structure.

In the study of social networks, of which the economic networks of interest here are a subset, few networks are “complete”—that is, all possible links between nodes are present. Rather, in most economic networks, like the biopharmaceutical network above, links between nodes are unevenly distributed. As noted above, this gives nodes unique positions within a network relative to other nodes. But it also gives networks unique structures.

For instance, the links between nodes might be randomly allocated.<sup>15</sup> Although this rarely happens in social settings, random networks are a useful benchmark—a null hypothesis that a network has no structure—against which to compare an actually occurring network that is of interest.

More likely is that we find an economic network whose links follow a more discernable attachment pattern. For example, a core-periphery structure may form where nodes prefer to connect with certain nodes over other nodes,

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14. See Matthew Jennejohn, *The Private Order of Innovation Networks*, 68 STAN. L. REV. 281, 337–53 (2016) (explaining the variables affecting the formation and nature of relational contracts).

15. A random network, sometimes called an Erdős-Rényi (E-R) network, is generated in one of the two following ways. The first method for generating an E-R network is to consider all graphs that have  $n$  nodes and  $M$  edges. Thus  $G(n, M)$  is simply one of the possible graphs chosen at random. The second and more common method is to connect nodes randomly. Thus  $G(n, p)$  is a graph with  $n$  nodes where each potential edge is included with a probability  $p$ , independent of every other edge. The degree distribution of the nodes in this second type of E-R network is approximated by a Poisson distribution. Consequently, E-R networks are often referred to as Poisson random networks.

resulting in some nodes serving as hubs in the network.<sup>16</sup> A “scale-free” network is a particularly extreme version of this structure, where a single highly connected node has daisy chains of links to other nodes.<sup>17</sup> Or perhaps an economic network will exhibit “small-world” characteristics, which involves local clustering among nodes but also relatively average path lengths from one node to another in the network.<sup>18</sup> This local clustering may occur in situations where links are formed between nodes with similar characteristics, an attachment pattern known as homophily.

Real-world networks rarely match stylized network structure with perfect fidelity. Consider, for instance, the biopharmaceutical network visualized in Figure 4 above. Biopharmaceutical companies rarely contract with a circumscribed group of partners repeatedly. 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 dance ball, where dancers constantly move around the room to find new partners.<sup>19</sup>

Biopharmaceutical companies’ persistent search for novel partners results in a single large, highly interconnected network of relationships among companies. It is not a series of tiny clusters of companies isolated from one another, like a small-world network. 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. Most companies, however, have far fewer connections; the majority only have one or two links to other firms.

As is discussed in the following Parts, the structure of contractual networks is beginning to occupy an important role in contract theory. Prior research has focused primarily upon the role networks may play in the use of informal enforcement institutions, as discussed in Part III. However, a relatively

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16. Albert-László Barabási & Réka Albert, *Emergence of Scaling in Random Networks*, 286 SCI. 509, 510–11 (1999).

17. *Id.*; see *infra* Figure 4.

18. See Duncan J. Watts & Steven H. Strogatz, *Collective Dynamics of ‘Small-World’ Networks*, 393 NATURE 440, 441 (1998) (illustrating small-world networks in contrast to regular and random network models). Small-world networks are named after the small-world phenomenon first described by Stanley Milgram. In his experiments, Milgram sent packages to randomly selected individuals in the Midwest with basic information about a target contact in Boston. They were asked to send the package directly to that person if they knew them on a first-name basis. Otherwise, they were to think of someone they knew on a first-name basis that would be more likely to know the target. The average path length of the letter chains that were successful was around five and a half or six, leading to the “six degrees of separation” known in popular culture. Stanley Milgram, *The Small World Problem*, 2 PSYCHOL. TODAY 61 (1967).

19. See, e.g., Powell et al., *Network Dynamics and Field Evolution*, *supra* note 10, at 1138; see also Powell et al., *Interorganizational Collaborations*, *supra* note 10, at 142 (1996) (concluding that “the 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).

unexplored possibility, particularly in legal scholarship, is that network structure also affects the way financial shocks propagate through a market.

### III

#### THE GROWING ROLE OF NETWORKS IN CONTRACT THEORY

Networks have long attracted the attention of contract scholars, but the focus has been almost entirely on their role in bilateral governance—particularly the role of networks in informal sanctions. 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 repeat player can credibly threaten to end a commercial relationship, which discourages bad behavior.<sup>20</sup> 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.<sup>21</sup> 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.”<sup>22</sup> Linking transactions through repeated dealings between two parties creates the stability required for consistent norms to emerge and allows an aggrieved party to punish an opportunistic counterparty, such as by terminating the relationship.<sup>23</sup> In summary, the enforcement of contractual obligations may be extra-legal.

#### A. The Scale of Private Ordering

For decades, much scholarship assumed that the role of reputational sanctions was limited to insular trading communities, where social connections

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20. Peter Moran, *Structural vs. Relational Embeddedness: Social Capital and Managerial Performance*, 26 STRAT. MGMT. J. 1129 (2005); Stewart Macaulay, *Non-Contractual Relations in Business: A Preliminary Study*, 28 AM. SOC. REV. 55, 63–64 (1963).

21. See, e.g., Lisa Bernstein, *Opting out of the Legal System: Extralegal Contractual Relations in the Diamond Industry*, 21 J. LEG. STUD. 115 (1992) (describing the diamond industry’s rejection of “state-created law” in favor of “an elaborate, internal set of rules, complete with distinctive institutions and sanctions to handle disputes among industry members.”).

22. AVNER GREIF, INSTITUTIONS AND THE PATH TO THE MODERN ECONOMY: LESSONS FROM MEDIEVAL TRADE 29 (2006); see also Avner Greif, *Contract Enforceability and Economic Institutions in Early Trade: The Maghribi Traders’ Coalition*, 83 AM. ECON. REV. 525 (1993) (exploring the “implicit contractual relations” of medieval European merchant guilds).

23. See, e.g., B. Douglas Bernheim & Michael D. Whinston, *Incomplete Contracts and Strategic Ambiguity*, 88 AM. ECON. REV. 902, 917–31 (1998) (discussing the dynamics and strategic implications of punishment in the context of the extralegal enforcement of transactions); W. Bentley MacLeod & James M. Malcomson, *Implicit Contracts, Incentive Compatibility, and Involuntary Unemployment*, 57 ECONOMETRICA 447 (1989) (examining “self-enforcing implicit contracts” in the realm of employment); W. Bentley MacLeod & James M. Malcomson, *Reputation and Hierarchy in Dynamic Models of Employment*, 96 J. POL. ECON. 832, 849–51 (1988) (explaining how employment termination contracts can be made “entirely self-enforcing, with no need for legal enforceability”); L. G. Telser, *A Theory of Self-Enforcing Agreements*, 53 J. BUS. 27 (1980) (investigating the conditions by which incompleteness in contracts prove optimal).

were tight.<sup>24</sup> 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 markets, where reputational sanctions amplify bilateral threats to stop dealing in the future.<sup>25</sup> 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.<sup>26</sup>

Bernstein introduces the network governance thesis in the context of heavy equipment supply chains.<sup>27</sup> Based on interviews with subjects originally identified in sociologist Josh Whitford's excellent study of collaboration among heavy equipment suppliers in the upper Midwest of the United States,<sup>28</sup> Bernstein finds qualitative evidence that suppliers operate within a network of relationships that limits the risk of opportunistic behavior by amplifying reputational sanctions.<sup>29</sup> 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.<sup>30</sup> 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. The news of doing so would quickly spread through the network, and other suppliers would demand a premium from that OEM in the future.<sup>31</sup>

Bernstein's recent work opens bracing new possibilities in the private

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24. A small cottage industry of ethnographic studies has arisen, from sovereign debt to tuna merchants in Tokyo to 11<sup>th</sup> century Jewish merchants in North Africa to organized crime to land courts in Papua New Guinea. See Sadie Blanchard, *Courts as Information Intermediaries: A Case Study of Sovereign Debt Disputes*, 2018 BYU L. REV. 497 (2018) (discussing the role of courts as arbiters of reputational sanctions); Eric A. Feldman, *The Tuna Court: Law and Norms in the World's Premier Fish Market*, 94 CALIF. L. REV. 313 (2006) (explaining how the tight-knit community of tuna fishermen use a highly specialized, efficient state-created court to resolve commercial disputes); GREIF, *supra* note 22 (examining the linkages of European merchant guilds); 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, 58–60 (2000) (arguing that organized crime syndicates act as reputational intermediaries competing with the state to enforce property rights); Robert D. Cooter, *Inventing Market Property: The Land Courts of Papua New Guinea*, 25 LAW & SOC'Y REV. 759 (1991) (exploring how land courts use intricate, local customs to adjudicate property disputes among kin).

25. Lisa Bernstein, *Beyond Relational Contracts: Social Capital and Network Governance in Procurement Contracts*, 7 J. LEGAL ANALYSIS 562, 563–64 (2016).

26. Lisa Bernstein, *Contract Governance in Small World Networks*, 113 NW. U. L. REV. 1009, 1014–15 (2019).

27. Bernstein, *supra* note 25, at 562–65.

28. JOSH WHITFORD, *THE NEW OLD ECONOMY: NETWORKS, INSTITUTIONS, AND THE ORGANIZATIONAL TRANSFORMATION OF AMERICAN MANUFACTURING* 51–117 (2005).

29. Bernstein, *supra* note 25, at 578–86.

30. *Id.* at 604–06.

31. *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”).

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.

## B. The Overlooked Potential Costs of Contractual Networks

Less appreciated, however, are the potential costs that contractual networks pose. For instance, in recent work, I argue that the literature on networks' role in informal governance overlooks the possibility that contractual networks exacerbate technological spillovers.<sup>32</sup> Having more connections, or becoming more "embedded" within a network, increases spillover risks. Collaborating with a company centrally positioned in the network increases the likelihood that technical information will leak out.<sup>33</sup> This is particularly problematic if one's current partner can later collaborate with one's competitors. That is a frequent occurrence in some markets, such as biopharmaceuticals, where "the pattern of cross-cutting collaborations often results in a partner on one project being a rival on another."<sup>34</sup>

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.<sup>35</sup> Uzzi's subsequent work built upon that foundation, introducing the idea that networks introduce a "paradox of embeddedness."<sup>36</sup> Analyzing contracting practices in the New York garment industry, Uzzi finds

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32. Jennejohn, *supra* note 11.

33. Matthew Jennejohn, *Braided Agreements and New Frontiers for Relational Contract Theory*, 45 J. CORP. L. 885, 913 (2020).

34. Powell et al., *Network Dynamics and Field Evolution*, *supra* note 10, at 1187.

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

36. Brian Uzzi, *Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness*, 42 ADMIN. SCI. Q. 35 (1997); Brian Uzzi, *The Sources and Consequences of Embeddedness for the Economic Performance of Organizations: The Network Effect*, 61 AM. SOC. REV. 674 (1996). 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. Michael Klausner, *Corporations, Corporate Law, and Networks of Contracts*, VA. L. REV. 757 (1995); Marcel Kahan & Michael Klausner, *Path Dependence in Corporate Contracting: Increasing Returns, Herd Behavior and Cognitive Biases*, 74 WA. U. L. Q. 347 (1996); Marcel Kahan & Michael Klausner, *Standardization and Innovation in Corporate Contracting (Or "The Economics of Boilerplate")*, 83 VA. L. REV. 713 (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 & ROBERT SCOTT, *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.

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. 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.<sup>37</sup>

In addition to the risk of technological spillovers, we might add financial distress as a risk that greater network connectivity raises. While the possibility of contagion in contractual networks is a familiar topic in the legal literature on regulation of financial institutions and markets,<sup>38</sup> it has been absent in legal scholarship on contracting in the real economy.<sup>39</sup>

#### IV

#### EMERGENCE, STRUCTURE, AND THE DIFFUSION OF DISRUPTIONS IN A NETWORK

The idea that contractual networks provide an avenue for financial distress to spread in a market is intuitive enough to stand on its own. We can model the spread of a shock with the simplest of diffusion models, and its plausibility is apparent. The earliest model for studying diffusion, developed by Frank Bass to study the spread of a technological innovation, does not include any network characteristics as parameters for diffusion.<sup>40</sup> Rather, the Bass model considers two key rates that contribute to diffusion. One is the rate at which individuals innovate or spontaneously adopt an innovation, and the other is the rate at which individuals adopt an innovation because other individuals have. When plotted, the model generates the familiar "S Curve," where adoption is gradual early in the time period, gains speed, and then tapers at the end of the time period.<sup>41</sup> Adapting the Bass approach to a contagion setting seems simple enough—the

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37. Andrew Schrank & Josh Whitford, *The Anatomy of Network Failure*, 29 SOC. THEORY 151, 160, 162 (2011).

38. See, e.g., Judge, *supra* note 4.

39. For early work that explores law's role in supporting production networks, but that does not explicitly address contagion problems, see Ariel Porat & Robert E. Scott, *Can Restitution Save Fragile Spiderless Networks*, 8 HARV. BUS. L. REV. 1 (2018); Alan Schwartz & Robert E. Scott, *Third-Party Beneficiaries and Contractual Networks*, 7 J. LEGAL ANALYSIS 325 (2015).

40. See Frank M. Bass, *A New Product Growth for Model Consumer Durables*, 15 MGMT. SCI. 215 (1969) (describing the development of a theory of timing of initial purchase of new consumer products); JACKSON, *supra* note 6, at 187–88.

41. This is an intuitive pattern as the initial adoption rate is low, because there are few individuals to adopt the innovation from. The system then enters the linear range, where individuals are able to adopt both by spontaneous innovation, as well as adoption from others. But as time continues, there are fewer individuals left to adopt and the adoption rate slows again.

spread of a shock in a market would largely be captured in that second rate in the model.

What a simple model like Bass's does not do well, however, is provide the granularity we need with respect to how that second rate might vary. For instance, consider how the Bass model might fare in explaining the propagation of a shock in the biopharmaceutical network depicted in Figure 3 above. Recall that the biopharmaceutical network has a core of highly connected nodes and a periphery of less connected ones, and that there is a relatively high amount of diversity with respect to connections between the two—that is, nodes in the core have a relatively high percentage of connections to the periphery, and vice versa. Now imagine that a shock, such as the labor or supply shortages that occurred in biopharmaceuticals during the COVID-19 pandemic, occurs.<sup>42</sup> The Bass model does not address the possibility that proximity to others in the network may vary across nodes—that is, some may be more central and others more peripheral—thereby affecting the diffusion paths of the shock. Nor does the Bass model allow us to think about how the location of a shock's origin in an exchange network—that is, a shock at the core versus a shock at the periphery—affects propagation. More nuanced models are necessary to uncover those dynamics.

#### A. Breadth: How Multisourcing Decisions Shape the Diffusion of Shocks

In recent years, research has begun exploring the spread of financial distress using a combination of network analysis and game theory.<sup>43</sup> Spurred in particular by the 2008–2009 financial crisis, most of this work has focused upon contagion in capital markets. More recently, work specifically dedicated to supply chains has been undertaken.

One of the field's core insights is that the dynamics of contagion are far more complicated than our simple intuitions appreciate. At the core of supply chain fragility is a puzzle. On one hand, increasing links in the network through a multisourcing strategy is a rational strategy for a buyer to pursue. If one supplier fails, then it is better to have a second supplier in place who can cover the lost production capacity. Diversifying risk increases the robustness of the buying firm.

At the same time, more links in the network may also speed up the spread of a shock. The intuition here is readily apparent in an epidemiological context: Increasing the connections between people increases the spread of a disease through a population, while isolating people slows it down. This is, for example, why public policies mandating or promoting social distancing were adopted widely during the COVID-19 pandemic. More connections between firms in an

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42. See WHITE HOUSE, BUILDING RESILIENT SUPPLY CHAINS, REVITALIZING AMERICAN MANUFACTURING, AND FOSTERING BROAD-BASED GROWTH: 100-DAY REVIEWS UNDER EXECUTIVE ORDER 14017 207–49 (June 2021), <https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf> [<https://perma.cc/V6GM-T8FK>]; Mariana P. Socal, Joshua M. Sharfstein & Jeremy A. Greene, *The Pandemic and the Supply Chain: Gaps in Pharmaceutical Production and Distribution*, 111 AM. J. PUB. HEALTH 635 (2021).

43. See generally Matthew O. Jackson & Agathe Pernoud, *Systemic Risk in Financial Networks: A Survey*, 13 ANN. REV. ECON. 171 (2021).

exchange network may provide more paths for the effects of a shock to spread.

Putting these two pieces of the puzzle together, prior research has found that shocks propagate through exchange networks non-monotonically.<sup>44</sup> In other words, increasing links within the network through a multisourcing strategy increases the likelihood of contagion, but a point arrives where more links in the network diversify risk sufficiently to prevent propagation of a shock. Exchange networks have a perverse “goldilocks zone” where there are enough links to spread a shock but too few links to provide the protection that diversification promises.

Relatedly, even robust networks may be overcome if the shock is large enough. Imagine, a well-connected company in an exchange network being overcome by a large shock despite diversification. In that case, the many connections in the network then spread the shock far and wide. In this sense, exchange networks have a tipping point between robustness and fragility, leading to their paradoxical description as “robust-yet-fragile.”<sup>45</sup>

Recent studies also provide evidence that the structure of the contractual connections within a market shape the likelihood of shock propagation. Certain network structures are more susceptible to cascades than others. In short, the raw number of links in the network can give us a rough sense of the likelihood of financial contagion, but more granular analysis of the structure of a network gives us a better sense of when and from where shocks will spread. This literature offers several lessons that help to sharpen our understanding of the role that contract network structure can play in crises.

First, and perhaps mostly clearly, studies have found that, holding other factors constant, shocks propagate more quickly in some network structures than others. A theme in a number of studies, for instance, is that a scale-free network structure is most resilient to shocks compared to other network types. For example, models of the interbank lending market reveal that the diffusion of shocks depends upon the structure of the contractual network. A scale-free network experiences the smallest contagions, though the failure of a central node can lead to exceptionally large shock propagations. A core-periphery network, however, where ten large organizations are connected among themselves, and each of ninety smaller organizations has one random connection to one of the large core organizations, experienced a swifter spread of financial contagion.<sup>46</sup>

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44. See Matthew Elliott, Benjamin Golub & Matthew O. Jackson, *Financial Networks and Contagion*, 104 AM. ECON. REV. 3115, 3118 (2014) (discussing a general model that produces new insights regarding financial contagions and cascades of failures among organizations linked through a network of financial interdependencies).

45. Andrew Haldane, *Rethinking the Financial Network*, in FRAGILE STABILITÄT – STABILE FRAGILITÄT 243, 249 (Stephan A. Jansen, Eckhard Schröter & Nico Stehr eds., 2013); Prasanna Gai, Andrew Haldane & Sujit Kapadia, *Complexity, Concentration and Contagion*, 58 J. MONETARY ECON. 453 (2011).

46. See Co-Pierre Georg, *The Effect of the Interbank Network Structure on Contagion and Common Shocks*, 37 J. BANKING & FIN. 2216 (2013) (proposing a dynamic multi-agent model of a banking system with a central bank).

Kim, Chen, and Linderman's study of supply network disruption in a variety of network structures finds similar evidence.<sup>47</sup> Again, in shocks involving either the failure of a node or the removal of a link, the study found that the scale-free network structure was by far the most resilient.<sup>48</sup> Relatedly, increasing network density (the number of links among nodes) decreased the network's resilience.<sup>49</sup> Tracing paths from a given raw material supplier, which is the start of a supply chain, to retailer, which is the end of a supply chain, also revealed that average, maximum, and minimum path lengths did not predict network resilience.<sup>50</sup>

Bintrup, Ledwoch, and Barros model supply chain disruptions in the global automotive industry and reach a similar conclusion.<sup>51</sup> Again, an increasingly interwoven topology is found to make the global automotive supply chains vulnerable to systemic risk.<sup>52</sup> Like a scale-free network, the global automotive supply network was found to be vulnerable to failures of large companies, but robust to random failures.<sup>53</sup>

A second, and related, lesson is that shocks propagate differently when networks exhibit community structures, such as local clusters of densely connected nodes. A number of studies examine the effect of homophily on network structure and the diffusion of shocks. Recall that homophily is present in a network when nodes in the network tend to prefer connecting to nodes with similar characteristics. Homophily often leads to a network with few connections between distinct groups of nodes—that is, a network with discrete sub-communities. Elliott, Golub, and Jackson observed that homophily can lead to lower contagion due to the severed connections between groups of organizations.<sup>54</sup> While this may increase resilience, Bintrup, Ledwoch, and Barros note that it does render the network particularly vulnerable to the failure of “bridging” nodes. Just like scale-free networks are found to be more resilient but vulnerable to the failure of a central hub, networks with greater community structure are vulnerable to the failure of a node that bridges two discrete groups. In that situation, the bridging node is the conduit for contagion that would otherwise be isolated within a sub-community in the network.

The third lesson is that how a shock diffuses through a network depends in part on the scale of the shock. Acemoglu, Ozdaglar, and Tahbaz-Salehi model financial contagion not only in a variety of financial network structures but also

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47. See Yusoon Kim, Yi-Su Chen & Kevin Linderman, *Supply Network Disruption and Resilience: A Network Structural Perspective*, 33 J. OPERATIONS MGMT. 43 (2015) (conceptualizing supply network disruption and resilience by examining the structural relationships among entities in the network).

48. *Id.* at 54.

49. *Id.*

50. *Id.*

51. See Alexandra Brintrup, Anna Ledwoch & Jose Barros, *Topological Robustness of the Global Automotive Industry*, 9 LOGISTICS RSCH. 1 (2016) (highlighting macroscopic and microscopic characteristics of large-scale interdependent networks).

52. *Id.* at 15.

53. *Id.*

54. Elliot et al., *supra* note 44, at 3142.

with different scales of shock.<sup>55</sup> They find that when a shock is small, then interdependencies among members of the network is advantageous, as risk is diversified and easily managed. When shocks are large, however, highly connected networks are particularly vulnerable to contagion.

Fourth, and finally, even isolated shocks can propagate throughout an exchange network. Recent work by Elliott, Golub, and Leduc finds that, in complex markets where supply networks provide multiple essential inputs, individual firms' incentives to multisource often lead markets to run too leanly, bringing them to a "precipice" at which even an isolated failure, such as a factory fire, at one supplier disrupts a large number of companies in the network.<sup>56</sup> In other words, even in a network with relatively customized sourcing relationships—where suppliers are providing buyers with bespoke products and not standardized commodities—a shock can diffuse. A supply network is only as strong as its weakest link.

In summary, the state of the art in the research on contagion in production networks paints a complicated picture. Simple diversification strategies that parties may pursue to hedge against supplier failure may increase the aggregate risk that a shock will propagate through a market. And even diversification that is efficient in the occurrence of small shocks may be harmful in the event of a large shock. Furthermore, the specific choices of partners that parties make affect the structure of the network that emerges. And variations in network structure can affect the outcomes of a shock. Creating contractual relationships in discrete clusters, for instance, or connecting primarily to a few central nodes to form a scale-free network may make the market more resilient in certain circumstances.

## B. Depth: Contract Design as a Tool For Shock Absorption

Although current research on the spread of financial distress adds nuance, it also leaves an important issue largely unaddressed. Another strategy for reducing the risk of supplier failure is greater collaboration—or seeking greater *depth* in the contractual relationship.<sup>57</sup> That is, rather than multisourcing, a buyer may reduce the scale of its sourcing, or even single source a sub-system, and engage in relational contracting with that supplier.<sup>58</sup>

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55. See Daron Acemoglu, Asuman Ozdaglar & Alireza Tahbaz-Salehi, *Systemic Risk and Stability in Financial Networks*, 105 AM. ECON. REV. 564 (2015) (arguing that the extent of financial contagion exhibits a form of phase transition: as long as the magnitude of negative shocks affecting financial institutions are sufficiently small, a more densely connected financial network (corresponding to a more diversified pattern of interbank liabilities) enhances financial stability).

56. Matthew Elliott, Benjamin Golub & Matthew W. Leduc, *Supply Network Formation and Fragility* 13–14 (Jan. 7, 2022) (unpublished manuscript), <https://arxiv.org/pdf/2001.03853.pdf> [<https://perma.cc/FSC8-VLBB>].

57. For insightful commentary on this possibility, see Denis Demblowski, *Can Relational Contracts Remove Supply Chain Rigidity?*, BLOOMBERG L. (Nov. 1, 2021), <https://news.bloomberglaw.com/bloomberg-law-analysis/analysis-can-relational-contracts-remove-supply-chain-rigidity> [<https://perma.cc/WZA9-HJHV>].

58. For an insightful discussion of when greater relational depth may be pursued, see Juliet P. Kostritsky, *A Bargaining Dynamic Transaction Cost Approach to Understanding Framework Contracts*,

The availability of relational contracting potentially affects shock propagation. The flexibility that comes through relational contracting may absorb shocks more readily, nipping shocks in the bud, as it were. The give and take that a relational contract makes available, even if circumscribed, may be enough to stop a shock from spreading from a troubled supplier to others. The opposite is also true: Refusing to be flexible and pushing suppliers on price in an arm's-length fashion increases the likelihood of default, as decades of experience in the automotive industry demonstrate.<sup>59</sup>

The COVID-19 pandemic has given us many examples of contract design affecting adjustments in commercial relationships that presumably affected the likelihood of a shock spreading.<sup>60</sup> For instance, the dramatic deal renegotiations in the mergers and acquisitions market were undertaken within the negotiating space afforded by merger agreements' material adverse effect provisions; Tiffany and Louis Vuitton's renegotiation being perhaps not only the most public but also the most fraught.<sup>61</sup> A casual study of commentary also suggests that investment in bilateral governance is a common strategy in situations of distress. For instance, Deloitte's advice to OEMs who have a troubled supplier includes "support, invest, and restore supplier health" and not solely attempting to exit the supply agreement.<sup>62</sup> Law firms advising OEMs in distressed supplier situations provide guidance on how to design accommodation agreements, which are used to "prop up the [distressed] supplier."<sup>63</sup>

It is important to acknowledge that investing in bilateral governance is not a viable option in many of the markets the contagion literature discussed above has studied. The systemically important financial markets that have occupied most scholarly attention rely heavily on standardized contracts to achieve their massive scale. In those markets, modeling contagion with the assumption that contracts are rigid and commoditized is most appropriate. In the supply chain context,

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68 AM. U. L. REV. 1621 (2019).

59. For a discussion of how automotive OEMs' tactics with suppliers were being adopted in the aerospace industry, see Joseph M. Geraghty, *Supply Chain Squeeze: Aerospace OEM's Rolling Out Template Used in Auto Supply Market for 30 Plus Years*, DAYTON BUS. J. (Nov. 18, 2014), <https://www.bizjournals.com/dayton/blog/2014/11/supply-chain-squeeze-aerospace-oem-s-rolling-out.html> [<https://perma.cc/UY3X-Z6JJ>].

60. See, e.g., Jonathan Lipson & Norman M. Powell, *Contracting COVID: Private Order and Public Good (Standstill)*, 76 BUS. LAW. 437 (2021) (exploring the important role that private ordering can play through the use of standstill/forbearance agreements).

61. See, e.g., Matthew Jennejohn, Julian Nyarko & Eric Talley, *Contractual Evolution* 1–4 (Ctr. for L. & Econ. Working Paper, Paper No. 654, 2021), [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3810214](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3810214) [<https://perma.cc/F94T-WA8Q>].

62. REED BINGAMAN, LAURENT BECHER, MICHAEL HELD, SEAN MCPHERSON, RAM SRIRAM & RAJ IYER, YOU ARE ONLY AS STRONG AS YOUR WEAKEST LINK: WHY MANUFACTURERS SHOULD MONITOR THEIR SUPPLIERS' HEALTH 5 (Deloitte ed., 2012), <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/manufacturing/us-auto-distressed-supplier%20management-03052013.pdf> [<https://perma.cc/DNG2-TPND>].

63. Ann Marie Uetz & Christopher R. Boll, *Working with Distressed Automotive Suppliers*, FOLEY & LARDNER (June 9, 2020), <https://www.foley.com/en/insights/publications/2020/06/considerations-financially-distressed-suppliers> [<https://perma.cc/5B22-MGNJ>]; see also Lipson & Powell, *supra* note 60.

however, customizing contractual governance to include relational flexibility is a more realistic option.

Recognizing the possibility that contract design may affect the diffusion of shocks opens two avenues for future research. The first avenue is in legal scholarship. It invites contract scholars to consider the diffusion effects of contracting parties' governance choices. Since the welfare-oriented approach of law and economics came to dominate contracts scholarship in the 1980s and 1990s, scholarship on contract design has focused squarely on how design choices affect parties' incentives to invest. That is, social benefit and harm are understood through the lens of underinvestment. Contracts' role in propagating diffusion adds a new frame for understanding contracting's role in affecting social welfare.

The effect of this new frame may be felt most immediately in the new scholarship on the role of networks in supporting informal sanctions. In that scholarship, greater network connections are seen as unalloyed benefits—the more connected a network, the faster reputational information spreads. The possibility that networks may also hasten the diffusion of contagion is a reason to be less sanguine about the promise of contractual networks. In that respect, the prospect of contagion complements the recent work on networks' roles in facilitating technological spillovers: Not only do contractual networks increase technological externalities, they also heighten the risk that financial distress spreads to third parties.

The second avenue is found in the social science research that models diffusion, as outlined above. One implication of the insight that contract design may affect shock propagation is that greater attention must be paid to link characteristics in diffusion models. In supply chains, where contracts may fall anywhere along a continuum between relational and arm's-length arrangements, links can have different qualities. Diffusion models should be designed to incorporate this insight, shedding light on how shocks, large and small, might spread depending on the nature of the contracts connecting participants in the market. In short, including more nuanced link characteristics in contagion modeling promises to improve our understanding of how shocks spread.

### C. The Interaction Between Breadth And Depth

Importantly, parties' breadth and depth strategies for limiting the harm of contagion are interrelated. This interrelationship arises, for instance, because relational contracting is typically not undertaken at the same scale as arm's-length sourcing.<sup>64</sup> Deepening a contractual relationship consumes internal resources, leading to fewer, but deeper, supplier connections. This in turn reduces the number of contractual links in an exchange network and affects overall network structure. On the other hand, the choice to broaden one's sourcing relationships often carries with it the implicit decision to reduce the extent of

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64. This, of course, assumes that one's investment in internal governance capacity is held constant. One may both broaden and deepen one's contractual relationships simultaneously if one is also willing to make greater investments in that internal capacity.

relational governance. In either respect, the specifics of microlevel contract design have important implications for macrolevel contagion patterns.

## V

### CONCLUSION: CONTINGENT INFRASTRUCTURE FOR A HETEROGENEOUS ECONOMY

Identifying the transactional dynamics of market fragility raises a number of implications for future research and policy. Perhaps the most obvious implication is the need for further empirical analysis of shock propagation in supply chains, which significantly lags adjacent work studying financial markets. On the legal side of the academic division of labor, developing a theory of contract design and enforcement that includes externalities such as the spread of shocks within an exchange network is also a priority. Subject to the further refinement that this research will provide, the following three policy implications also arise.

First, the research already undertaken suggests that exchange networks are highly heterogeneous in their structures, and that shocks propagate differently across networks due to those different structures and a variety of other factors. That diversity, in turn, suggests that any regulatory response tasked with addressing the spread of distress within a network will have to be sufficiently flexible to tailor its intervention to a meaningful extent to the network type in which it is operating. The threshold requirement for success, then, is identifying and understanding the structure of exchange networks, and how contagion spreads differently through them.<sup>65</sup> Without such an ability, any regulatory intervention will be like flying an airplane without instrumentation.

Second, building regulatory capacity to analyze network structure and dynamics, particularly in the heat of a crisis, is a long-term project, if such would be politically feasible at all. The institutional investment required for the administrative state to play such a role raises the question of whether alternative methods might be used. Of course, the private sector offers services and technology for supply chain monitoring, which can improve visibility for companies in a supply chain and allow them to better anticipate the spread of a shock. At the same time, enhanced visibility, alone, certainly was not enough to prevent the diffusion of COVID-19's disruption around the globe. This raises the question of whether a middle ground might be possible—a distributed response that nonetheless has the resources and imprimatur of the state.

Here, contract law's excusal doctrines are an intriguing possibility. To deploy them accurately, however, would require (1) modeling how excusing a parties' performance obligation affects shock propagation among other companies under stress in a dynamic network; (2) likely refashioning the triggers for excusal to incorporate contagion risk, and not just contracting parties' mistakes about

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65. For an illustrative proposal on how to use simple centrality measures to steer intervention in financial markets, see Luca Enriques, Alessandro Romano & Thom Wetzer, *Network-Sensitive Financial Regulation*, 45 J. CORP. L. 351–98 (2020).

fundamental assumptions of their agreements; (3) increasing generalist courts' ability to understand and apply excusal doctrines in crisis settings; and (4) providing the resources necessary to the judiciary to expedite dispute resolution during a crisis. Even if a decentralized solution is less costly than more centralized regulatory intervention, those four factors are nevertheless tall orders.<sup>66</sup>

This leads us to the third implication, which is that perhaps the most cost-effective way of addressing the spread of shocks through the real economy is improving contract design. Encouraging investment in bilateral governance may provide more contractual shock absorbers throughout an exchange network, for instance. Or perhaps directing collaboration toward particular partners can create more resilient network structures in the first place. The most cost-effective fix may come from an unlikely place: Transactional lawyers.

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66. For further thoughtful discussion on courts' capabilities in this regard, see Anthony Casey & Anthony Niblett, *The Limits of Public Contract Law*, 85 LAW & CONTEMP. PROBS., no. 2, 2022, at 51.