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SPILL YOUR (TRADE) SECRETS: KNOWLEDGE NETWORKS AS INNOVATION DRIVERS

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Abstract

Theories of intellectual property take the individual inventor or the firm as the unit of innovation. But studies in economic sociology show that in complex fields where knowledge is rapidly advancing and widely dispersed among different firms, the locus of innovation is neither an individual nor a single firm. Rather, innovative ideas originate in the informal networks of learning and collaboration that cut across firms.

Understanding innovation in this subset of industries as emerging out of networks of informal information-sharing across firms challenges traditional utilitarian theories of trade secret law—which assume trade secret protection is needed to prevent excessive private, self-help efforts to preserve secrecy. Doctrinally, knowledge network research suggests that the scope of trade secret protection in these industries should be narrow. In these industries, strong trade secret rights that grant managers tight control over employee-inventors' informal information-sharing practices are bad innovation policy. Rather, optimizing trade secret law requires tailoring the strength of protection to match industry characteristics, narrowing trade secret scope in those industries where informal information-sharing networks are predicted to enhance innovative output. In turn, because industry types tend to cluster around geographic centers, the importance of tailoring cautions against current trends towards uniformity by federalizing trade secret law and favors state experimentalism in designing trade secret law and policy.

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INTRODUCTION

Where does innovation take place? Under traditional theories of intellectual property, the answer to this question seems rather obvious. Innovation takes place inside individual firms, where inventors and, increasingly, teams of inventors lead research and development efforts.[1] But economic sociology studies show that in complex fields where knowledge is both rapidly advancing and widely dispersed across firms, the locus of innovation is no longer a specific firm.[2] Rather, innovative ideas often originate in informal networks of learning and collaboration that cut across firms.[3] Shifting the unit of innovation from the firm (or the individual) to the network of relationships in which these actors are embedded has important consequences for intellectual property theory and practice. This Article focuses on one such consequence: the implications of informal, cross-firm networks of innovation for trade secret theory and doctrine, and for the overlap between state and federal trade secret protection. This Article shows how, in a subset of science-based industries, where innovation is fast paced and needed knowledge is widely distributed among firms, innovation is likely to proceed more efficiently when networks of informal know-how sharing are encouraged. In these industries, strong trade secret rights that grant managers tight control over employee-inventors' informal information-sharing practices would be bad innovation policy. Rather, optimizing trade secret law requires tailoring the strength of protection to match industry characteristics, narrowing trade secret scope in those industries where informal information-sharing networks are predicted to enhance innovative output. In turn, because industry types tend to cluster around geographic centers, the importance of tailoring cautions against current trends towards uniformity by federalizing trade secret law and favors state experimentalism in designing trade secret law and policy.

Contrary to traditional assumptions in intellectual property theories, a large and growing body of historical and empirical work reveals that informal information-exchange networks across firm boundaries can be crucial to spur innovation. As historical studies document, in the Industrial Revolution—an era of technological explosion that many attribute to the increased availabil-

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1 *See infra* Section I.A; *see also* Stefan Wuchty et al., *The Increasing Dominance of Teams in Production of Knowledge*, 316 SCI. 1036, 1036–39 (2007) (emphasizing the rise of teams in modern-day innovation).

2 *See infra* Sections I.B, I.C; *see also* Naomi R. Lamoreaux et al., *Beyond Markets and Hierarchies: Toward a New Synthesis of American Business History*, 108 AM. HIST. REV. 404 (2003); Walter W. Powell, *Neither Market nor Hierarchy: Network Forms of Organization*, *in* 12 RES. IN ORG. BEHAV. 295, 308–09 (1990); Walter W. Powell et al., *Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology*, 41 ADMIN. SCI. Q. 116 (1996); Walter Powell & Eric Giannella, *Collective Invention and Inventor Networks*, *in* HANDBOOK ECON. INNOVATION (Bronwyn Hall & Nathan Rosenberg eds., 2009).

3 Powell, *supra* note 2, at 295; *see also* Laura Pedraza-Fariña, *The Social Origins of Innovation Failures*, 70 SMU L. REV. (forthcoming 2017).

ity of intellectual property protection[4]—a subset of industries made breakthrough advances precisely by eschewing trade secret protection.[5] Instead, in these industries, including fundamental steam engine technology, engineers who worked for competing firms but belonged to the same epistemic community[6] freely and reciprocally shared know-how across firm boundaries.[7] More recently, empirical studies in the biotechnology, semiconductors, and information technology industries reveal a similar trend: important modern discoveries were enabled by informal networks of information-sharing across competing firms.[8]

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4 *See, e.g.*, Joel Mokyr, *Intellectual Property Rights, the Industrial Revolution, and the Beginnings of Modern Economic Growth*, 99 AM. ECON. REV., no. 2, 2009, at 349, 352.

5 *See infra* Section I.B; *see also* JOEL MOKYR, A CULTURE OF GROWTH (2016) (arguing that a culture of open sharing that was prevalent among the European scientific community—but absent in China—explains why the Industrial Revolution began and flourished in the West); Robert C. Allen, *Collective Invention*, 4 J. ECON. BEHAV. AND ORG. 1 (1983); Alessandro Nuvolari, *Collective Invention During the British Industrial Revolution: The Case of the Cornish Pumping Engine*, 28 CAMBRIDGE J. ECON. 347 (2004); Eric von Hippel, *Cooperation Between Rivals: Informal Know-How Trading*, 16 RES. POL. 291 (1987); Eric von Hippel & Georg von Krogh, *Open Innovation and the Private-Collective Model for Innovation Incentives*, *in* THE LAW AND THEORY OF TRADE SECRECY: A HANDBOOK OF CONTEMPORARY RESEARCH (Rochelle C. Dreyfuss & Katherine J. Strandburg, eds. 2011).

6 I adopt Peter Haas's definition of epistemic community: "a network of professionals with recognized expertise and competence in a particular domain and an authoritative claim to policy-relevant knowledge within that domain or issue-area." Peter M. Haas, *Introduction: Epistemic Communities and International Policy Coordination*, 46 INT'L ORG. 1, 3 (1992). Epistemic communities are also sociological groups that share a common culture or "common style of thinking." *Id.* at 3 n.4; *see also* Laura Pedraza-Fariña, *Patent Law and the Sociology of Innovation*, 2013 WIS. L. REV. 813, 838–40 (describing sociological and historical analyses of scientific communities, including different terminologies used to describe scientific groups with a common set of social ties and expert knowledge bases). The existence of an epistemic community with a common set of social norms enables the emergence of information-sharing networks.

7 *See* Allen, *supra* note 5; Nuvolari, *supra* note 5. Firms can also exchange information through other, more formal means, such as agreements to license or sell proprietary know-how and agreements to perform R&D cooperatively. These types of exchanges have been more widely studied (in particular in the management literature) than the informal informational exchanges addressed in this Article. *See, e.g.*, René Belderbos, Martin Carree & Boris Lokshin, *Cooperative R&D and Firm Performance*, 33 RES. POL. 1477 (2004); John Hagedoorn, *Inter-firm R&D Partnerships: An Overview of Major Trends and Patterns Since 1960*, 31 RES. POL. 477 (2002); John Hagedoorn, Albert N. Link & Nicholas S. Vonortas, *Research Partnerships*, 29 RES. POL. 567 (2000).

8 *See, e.g.*, David P. Angel, *The Labor Market for Engineers in the U.S. Semiconductor Industry*, 65 ECON. GEOGRAPHY 99 (1989); Michael Slavensky Dahl & Christian Ø.R. Pedersen, *Knowledge Flows Through Informal Contacts in Industrial Clusters: Myth or Reality?*, 33 RES. POL. 1673 (2004); Lee Fleming & Koen Frenken, *The Evolution of Inventor Networks in the Silicon Valley and Boston Regions*, 10 ADVANCES COMPLEX SYS. 53 (2007); Michelle Gittelman, *Does Geography Matter for Science-Based Firms? Epistemic Communities and the Geography of Research and Patenting in Biotechnology*, 18 ORG. SCI. 724 (2007); Kelley Porter, Kjersten Bunker Whittington & Walter W. Powell, *The Institutional Embeddedness of High-Tech Regions: Relational Foundations of the Boston Biotechnology Community*, *in* CLUSTERS, NETWORKS, AND INNOVATION

The prevalence of these informal information exchanges challenges three long-standing assumptions in traditional utilitarian theories of trade secret law. First, utilitarian theories predict that, absent trade secret protection, firms will overinvest in self-help measures to preserve secrecy.[9] Second, lack of trade secret protection is predicted to fragment scientific and technological research by incentivizing firms to only selectively disclose information to employees, thus hampering internal collaboration.[10] Third, absent protections against misappropriation provided by trade secret law, firms are predicted to underinvest in employee training.[11]

Why does traditional utilitarian theory get firm behavior wrong? Because it fails to realize that there is a second possible response to low trade secret protection. Knowledge network research tells us that, when it is hard to keep information secret, some industries will build reciprocal information-sharing innovation networks—rather than higher walls to protect their secrets.[12] When innovation networks form, the precise opposite of knowledge fragmentation takes place: informal interactions within and across firms incentivize knowledge recombination and synthesis, often leading to breakthrough innovation.[13] Employee learning also grows exponentially at networks through exposure to ideas from multiple institutional cultures.[14]

What are the implications of knowledge network studies for trade secret doctrine?[15] Applying knowledge network studies to trade secret law suggests two conditions where low trade secret protection is more likely to lead to

(Stefano Breschi & Franco Malerba eds., 2005); Powell et al., *supra* note 2; Powell & Giannella, *supra* note 2; Walter Powell, Kelley Packalen & Kjersten Whittington, *Organizational and Institutional Genesis: The Emergence of High-Tech Clusters in the Life Sciences*, *in* THE EMERGENCE OF ORGANIZATIONS AND MARKETS (Padgett & Powell eds., 2012); Everett M. Rogers, *Information Exchange and Technological Innovation*, *in* THE TRANSFER AND UTILIZATION OF TECHNICAL KNOWLEDGE 105 (Devendra Sahal ed., 1982); Stephan Schrader, *Informal Technology Transfer Between Firms: Co-Operation Through Information Trading*, 20 RES. POL. 153 (1991); Lauren Smith-Doerr & Walter Powell, *Networks and Economic Life*, *in* THE HANDBOOK OF ECONOMIC SOCIOLOGY (2003).

9 *See infra* Section II.A.

10 *See infra* Section II.A.

11 *See infra* Section II.A.

12 *See infra* Section I.B (summarizing historical studies); Section I.C (summarizing empirical studies of modern innovation).

13 *See infra* Section II.B.

14 *See infra* Section II.B.

15 One key objection to the proposals advanced in this Article can be framed as follows: Why, if informal information-sharing is, overall, beneficial to firm performance, don't firms simply encourage informal information-sharing networks? Why does trade secret law matter at all in these industries? The answer to this question is two-fold. First, firms suffer from well-understood collective action problems: although it would be in the collective interest of all firms in the region to facilitate informal information-sharing, any given firm would prefer to receive information but keep internally-produced information secret. Second, as this Article discusses in Section II.B, managers' and inventors' background norms and incentives conflict. From the perspective of overall social welfare, however, there is mounting empirical evidence that in these fields, public welfare is better aligned with inventors' incentives than with those of managers.

local, open information sharing than to excessive efforts at secrecy: (1) complex innovation (where technological progress is rapid and knowledge is widely dispersed among firms);[16] and (2) a background, local epistemic community with social norms of open-sharing (often affiliated with a university that anchors a technology cluster).[17] When these two conditions are fulfilled, this Article argues, courts should interpret trade secret law narrowly by (1) expanding the scope of what constitutes general technical knowledge that is ineligible for trade secret protection (for example, by excluding technical negative know-how[18] from the scope of trade secret protection); (2) defining an employee's implied duty of loyalty narrowly, absent an express contract provision; and (3) refusing to apply the "inevitable disclosure doctrine" absent a showing of bad faith on the part of the employee.[19]

Further, the geographic clustering of complex innovation industries by state,[20] and the importance of fostering local information exchange to form successful clusters, argues for a robust role for states in designing specific trade secret laws to fit the needs of their particular local state industries. In turn, the local and contextual impact of trade secret law on innovation highlights the importance of policing the overlap between the newly created federal cause of action for trade secret misappropriation (the Defend Trade Secrets Act)[21] and state trade secret law—lest the ability of states to tailor trade secret doctrine get swept away by the drive for uniformity.

The idea that innovation can take place in networks is, of course, not new. Studies on the role of networks in innovation (and related studies on innovation clusters) stretch back to the 1980s in management, sociological, and economics literature.[22] In law, scholars such as Yochai Benkler and Julie Cohen have focused on the importance of networks for the social, non-market production of knowledge.[23] Additionally, both business and legal scholars have written extensively about the rise of "open innovation" and "user

16 *See infra* Sections I.B, I.C.

17 *See infra* Sections I.B, I.C.

18 Negative know-how refers to information about "blind alleys" or failed experiments. Charles Tait Graves, *The Law of Negative Knowledge: A Critique*, 15 TEX. INTELL. PROP. L.J. 387, 410 (2007).

19 *See infra* subsection III.A.3.

20 Industries that are both complex and anchored to an epistemic network of inventors often locate at geographic "centers." For example, Boston, San Diego, and Silicon Valley have a high density of biotechnology and IT companies. This suggests that tailoring can take place through state-by-state variation of trade secret law to fit local state industry profiles. *See infra* Section III.B.

21 Defend Trade Secrets Act of 2016, Pub. L. No. 114-153, 130 Stat. 376 (codified as amended in scattered sections of 18 U.S.C.).

22 *See, e.g.*, Ronald S. Burt, *Innovation as a Structural Interest: Rethinking the Impact of Network Position on Innovation Adoption*, 2 SOC. NETWORKS 327 (1980); J. Carlos Jarillo, *On Strategic Networks*, 9 STRATEGIC MGMT. J. 31 (1988); Michael L. Tushman & Richard R. Nelson, *Introduction: Technology, Organizations and Innovation*, 35 ADMIN. SCI. QUART. 1 (1990).

23 *See generally* YOCHAI BENKLER, THE WEALTH OF NETWORKS: HOW SOCIAL PRODUCTION TRANSFORMS MARKETS AND FREEDOM (2006); JULIE E. COHEN, CONFIGURING THE NETWORKED SELF: LAW, CODE, AND THE PLAY OF EVERYDAY PRACTICE (2012); *see also generally* Pedraza-

innovation" models—two ideas that are related to the concept of networks.[24] A growing literature in contract law also focuses on formal and informal arrangements among firms that enable collaborative research.[25] This literature pays close attention to informal norms that facilitate dealings between firms, but the emphasis in this line of scholarship is on the creation of informal bonds of trust through formal contractual mechanisms and on the informal enforcement of these formal contractual promises. The literature on informal exchanges of know-how through epistemic community networks remains thin.[26] Finally, employment and intellectual property scholars have focused on the importance of employee migration for innovation in high-velocity industries in the context of intellectual property and contractual policies that can curtail such migration.[27]

Fariña, *supra* note 3 (analyzing social barriers to the productive flow and recombination of ideas).

24 *See, e.g.*, Carliss Baldwin & Eric von Hippel, *Modeling a Paradigm Shift: From Producer Innovation to User and Open Collaborative Innovation*, 22 ORG. SCI. 1399 (2011); Gaia Bernstein, *Incentivizing the Ordinary User*, 66 FLA. L. REV. 1275 (2015); Gaia Bernstein, *The End User's Predicament: User Standing in Patent Litigation*, 96 B.U. L. REV. 1929 (2016); Gaia Bernstein, *The Rise of the End User in Patent Litigation*, 55 B.C. L. REV. 1443 (2014); Julie E. Cohen, *The Place of the User in Copyright Law*, 74 FORDHAM L. REV. 347 (2005); Rochelle Cooper Dreyfuss, *Does IP Need IP? Accommodating Intellectual Production Outside the Intellectual Property Paradigm*, 31 CARDOZO L. REV. 1437 (2010); William W. Fisher III, *The Implications for Law of User Innovation*, 94 MINN. L. REV. 1417 (2010); Katherine J. Strandburg, *Users as Innovators: Implications for Patent Doctrine*, 79 U. COLO. L. REV. 467 (2008); Joel West & Marcel Bogers, *Leveraging External Sources of Innovation: A Review of Research on Open Innovation*, 31 J. PRODUCT INNOVATION MGMT. 814 (2013). The concept of open innovation is often linked with the Open Source movement in software development, which is one of the most visible examples of open innovation's successes. Indeed, the informal information-sharing networks in Silicon Valley described in this Article overlap with the networks of software engineers that facilitated the Open Source movement's emergence. *See, e.g.*, E. GABRIELLA COLEMAN, CODING FREEDOM: THE ETHICS AND AESTHETICS OF HACKING (2013); JOSH LERNER & MARK SCHANKERMAN, THE COMINGLED CODE (2010); Michael J. Madison, *Open Secrets*, *in* THE LAW AND THEORY OF TRADE SECRECY: A HANDBOOK OF CONTEMPORARY RESEARCH, *supra* note 5, at 222 (arguing that trade secret law can serve a structural function in managing—and preserving—protected knowledge commons); Geertrui Van Overwalle, *Uncorking Trade Secrets: Sparking the Interaction Between Trade Secrecy and Open Biotechnology*, *in* THE LAW AND THEORY OF TRADE SECRECY: A HANDBOOK OF CONTEMPORARY RESEARCH, *supra* note 5, at 246.

25 *See, e.g.*, Gillian K. Hadfield & Iva Bozovic, *Scaffolding: Using Formal Contracts to Support Informal Relations in Support of Innovation*, 2016 WIS. L. REV. 981; Ronald J. Gilson, *Locating Innovation: The Endogeneity of Technology, Organizational Structure, and Financial Contracting*, 110 COLUM. L. REV. 885 (2010); Ronald J. Gilson, Charles F. Sabel & Robert E. Scott, *Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration*, 109 COLUM. L. REV. 431 (2009); Ronald J. Gilson, Charles F. Sabel & Robert E. Scott, *Braiding: The Interaction of Formal and Informal Contracting in Theory, Practice, and Doctrine*, 110 COLUM. L. REV. 1377 (2010).

26 *See supra* note 25.

27 *See, e.g.*, ALAN HYDE, WORKING IN SILICON VALLEY: ECONOMIC AND LEGAL ANALYSES OF A HIGH-VELOCITY LABOR MARKET (2003); ORLY LOBEL, TALENT WANTS TO BE FREE: WHY WE SHOULD LEARN TO LOVE LEAKS, RAIDS, AND FREE-RIDING (2013); Catherine L. Fisk, *Working*

This Article adds to this vast, yet incomplete, literature a focus on the importance of informal information-sharing networks for innovative output in a subset of industries. This Article also updates current understandings of the role of informal networks in the legal literature by incorporating research from sociology and economics that seeks to identify *which types of industries* are likely to benefit from informal information-sharing through networks. Finally, this Article emphasizes a little-discussed phenomenon with important consequences for the design of trade secret law: the conflict between managers' and inventors' practices and background norms towards know-how sharing.

The remainder of this Article proceeds as follows. Part I demonstrates the prevalence and the primacy of knowledge networks in historical and modern incidences of innovation. Part II applies insights about the pro-innovation effects of knowledge networks on trade secret theory. Part III turns from theory to doctrine, and begins to explore how states can tailor trade secret doctrine to support the emergence of informal information exchanges in this subset of industries.

I. Knowledge Networks as Innovation Drivers

A. *The Traditional View: Firms and Individuals as Innovators*

Building upon Ronald Coase's foundational article *The Nature of the Firm*,[28] scholars have studied the dynamics of innovation by focusing on the firm (and its decision to "make or buy" an innovation) as the appropriate unit of analysis.[29] Firms will "make" an innovation in-house when the transaction costs of buying the innovation in the market are prohibitively high.[30]

Knowledge: Trade Secrets, Restrictive Covenants in Employment, and the Rise of Corporate Intellectual Property, 1800–1920, 52 Hastings L.J. 441 (2001); Catherine Fisk, *Workplace Knowledge and the Mobile Employee*, *in* Business Innovation: A Legal Balancing Act (Marilyn Pittard et al. eds., 2013); Catherine Fisk & Adam Barry, *Contingent Loyalty and Restricted Exit: Commentary on the* Restatement of Employment Law, 16 Emp. Rts. & Emp. Pol'y J. 413 (2012); 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, *The New Cognitive Property: Human Capital Law and the Reach of Intellectual Property*, 93 Tex. L. Rev. 789 (2015).

28 R.H. Coase, *The Nature of the Firm*, 4 Economica 386 (1937).

29 *See, e.g.*, Paul J. Heald, *A Transaction Costs Theory of Patent Law*, 66 Ohio St. L.J. 473 (2005); Robert P. Merges, *A Transactional View of Property Rights*, 20 Berkeley Tech. L.J. 1477 (2005); Laura Poppo & Todd Zenger, *Testing Alternative Theories of the Firm: Transaction Cost, Knowledge-Based, and Measurement Explanations for Make-or-Buy Decisions in Information Services*, 19 Strategic Mgmt. J. 853 (1998); Gordon Walker & David Weber, *A Transaction Cost Approach to Make-or-Buy Decisions*, 29 Admin. Sci. Q. 373 (1984); Oliver E. Williamson, *The Economics of Organization: The Transaction Cost Approach*, 87 Am. J. Soc. 548 (1981).

30 *See* Alfred Chandler, Jr., The Visible Hand: The Managerial Revolution in American Business (1977). Chandler ascribed the superiority of U.S. firms in the twentieth century to their vertically integrated organizational structure. *See id.* According to Chandler, the "visible hand" of management provided a superior coordination mechanism to the "invisible hand" of the market. *Id.* This view has subsequently been challenged by

Conversely, firms will "buy" an innovation in the market when the transaction costs are lower than in-house production costs.[31] Hierarchical firms exist, as Coase postulated, because some production functions are more efficiently performed under the direct command and control of a single entity than through market coordination.[32] In sum, the "make or buy" decision depends on comparing the transaction costs of each option.[33]

Viewing innovation from the perspective of a firm's decision to "make or buy" has led several law and economics scholars and property theorists to focus on the impact of intellectual property regimes on transaction costs both across and within firms. For example, Oren Bar-Gill and Gideon Parchomovsky argue that the strength of intellectual property rights determines the boundary between the firm and the market.[34] In this model, strong patent and trade secret rights—by giving legal protection to information—allow more production activities to shift from firms to the market.[35] Weak rights lead to the vertical integration of more innovative activity within a firm.[36] Similarly, Robert Merges and Ashish Arora have demonstrated that strong IP rights give rise to smaller firms specializing in the supply of technology inputs—again, moving production activities towards the market.[37] Scholars have also studied the impact of intellectual property protection on a firm's internal organizational structure. For example, Dan Burk argues that both patent law and trade secret protection can serve to regulate the interactions of employees with each other and with their employer.[38] And Paul Heald has postulated a role for patent law in regulating transactions among team members within a firm.[39]

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economic historians as suffering from a "presentist" bias that "view[s] the present as the final stage in an evolutionary process and thus, effectively, the end point of business history." Lamoreaux et al., *supra* note 2, at 405. Indeed, shortly after the publication of Chandler's work it became clear that, at least in some industries, firms employing decentralized production mechanisms were able to surpass their vertically integrated competitors. *Id.*

31 Lamoreaux et al., *supra* note 2, at 423.

32 Coase, *supra* note 28.

33 *See, e.g.*, Ashish Arora & Robert P. Merges, *Specialized Supply Firms, Property Rights, and Firm Boundaries*, 13 INDUS. & CORP. CHANGE 451 (2004); Oren Bar-Gill & Gideon Parchomovsky, *Law and the Boundaries of Technology-Intensive Firms*, 157 U. PA. L. REV. 1649 (2009); Dan L. Burk, *Intellectual Property and the Firm*, 71 U. CHI. L. REV. 3 (2004); 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.

34 *See* Oren Bar-Gill & Gideon Parchomovsky, *Intellectual Property Law and the Boundaries of the Technology-Intensive Firm* 1–2, (Harvard John M. Olin Discussion Paper Series, Discussion Paper No. 480, 2004).

35 *Id.*

36 *Id.*

37 *See* Arora & Merges, *supra* note 33.

38 *See* Burk, *supra* note 33, at 20.

39 *See* Heald, *supra* note 29, at 487; *see also* Bar-Gill & Parchomovsky, *supra* note 34, at 2 ("Trade secret law and the legal treatment of covenants not to compete similarly affect

This view of innovation divides the location of innovative activity into two distinct arenas, both tied to the firm as the unit of innovation[40]: (1) arms-length contracting between firms in the market; and (2) vertically-integrated production relationships inside firms.[41] While the market organizes production functions through bargaining, the firm does so through a hierarchical command-and-control structure.[42]

But studies on economic sociology show that there is a third arena where innovation takes place. While economists and organization theorists tend to focus on the rise of the "research corporation" (or research firm) as a key driver of innovation in the twentieth century, sociologists (and sociologically oriented economists) and historians of technology have emphasized the importance of innovation networks.[43] In industries with complex and rapidly advancing knowledge frontiers, important innovations take place neither within a firm nor through market transactions. Rather, they emerge out of a network of informal know-how exchanges among innovators in (often com-

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firm boundaries by determining the allocation of entitlements between firms and employees.").

40 Of course, within the firm it is individuals and teams of individuals who innovate. And important innovation does happen outside the firm. Indeed, a large body of literature in intellectual property has sought to identify how intellectual property entitlements impact individual motivations to innovate, and how firm and individual-level motivations interact. *See, e.g.*, LOBEL, *supra* note 27; Stephanie Plamondon Bair, *The Psychology of Patent Protection*, 48 CONN. L. REV. 297 (2015) (arguing that the idea that intellectual property protection motivates innovation needs to be reevaluated); Peter DiCola, *Money from Music: Survey Evidence on Musicians' Revenue and Lessons About Copyright Incentives*, 55 ARIZ. L. REV. 1 (2013) (showing through survey evidence that only a small percentage of musicians receive direct financial rewards from the copyright system); Lobel, *supra* note 27, at 790–91 (criticizing the expanding web of contractual agreements that surround employment contracts, including covenants not to compete, and increased reliance on trade secrets for dampening individual creativity); Jessica Silbey, *Harvesting Intellectual Property: Inspired Beginnings and "Work-Makes-Work," Two Stages in the Creative Processes of Artists and Innovators*, 86 NOTRE DAME L. REV. 2091, 2093 (2011) (showing through interview studies that intellectual property protection plays a small role in motivating artists and inventors (many of whom work within firms) to create).

41 *See, e.g.*, Bar-Gill & Parchomovsky, *supra* note 33, at 1650 ("The question thus becomes which stages of the inventive process should be integrated in a single firm and which should be divided among different firms and traded on the market?"); Lamoreaux et al., *supra* note 2.

42 In the 1970s and 1980s, economic historians and economists also focused almost exclusively on the firm and not on industrial districts. *See* Francisco J. Ortega-Colomer, *Discussing the Concepts of Cluster and Industrial Districts*, 11 J. TECH. MGMT. INNOVATION 139 (2016) (discussing the history of the emergence of the industrial district as compared to the former study of only the firm district).

43 *See, e.g.*, Ranjay Gulati, *Alliances and Networks*, 19 STRATEGIC MGMT. J. 293 (1998); Lamoreaux, et al., *supra* note 2; Powell, *supra* note 2; Powell et al., *supra* note 2; Powell & Giannella, *supra* note 2; Powell, Packalen & Whittington, *supra* note 8, at 434; *see also* Joel M. Podolny & Karen L. Page, *Network Forms of Organization*, 24 ANN. REV. SOC. 57, 59 (1998) (describing networks as collections of actors who pursue "repeated, enduring exchange relations with one another and, at the same time, lack a legitimate organizational authority to arbitrate and resolve disputes that may arise during the exchange").

peting) firms.[44] Walter Powell has theorized that networks represent a distinct third "locus" of innovation under which "cooperation and collaboration proceed with only limited reliance on contracts and the legal system, on the one hand, and on administrative fiat and bureaucratic routines, on the other."[45]

The next two sections synthesize historical and empirical studies on the role of networks in innovation. They highlight the surprising historical significance of innovation networks during the Industrial Revolution and their enduring relevance in modern innovation environments. Through this synthesis, this Article also uncovers a longstanding tension between "manager" and "inventor" incentives vis-à-vis informal know-how trading within individual firms.[46] Both during the Industrial Revolution and in present-day innovation clusters, inventors in complex industries are often members of epistemic communities of engineers, biologists, chemists, and others that transcend firm boundaries. When those epistemic communities favor openness and information sharing, and instill in their members an individual interest in the overall advancement of a particular technology, inventors working in disparate firms demonstrate a tendency for reciprocal informational exchange across firms. In contrast, managers are more likely to eschew information-sharing across firm boundaries, even when such sharing is likely to be reciprocal, and therefore likely to benefit all firms in the industry.

B. Innovation Networks: Historical Studies

No study on the history of technology would be complete without an analysis of the role of the Industrial Revolution on the rate of technological change. Eighteenth- and nineteenth-century technological advances in steam engine, iron production, and textiles technologies are widely credited with transforming predominantly agrarian, rural societies in Europe and America into industrial and urban centers.[47] The canonical view of the ori-

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44 *See supra* note 43.

45 Powell, *supra* note 2, at 328.

46 This tension is distinct from the fundamental tension between inventors' desires for autonomy and mobility, and managers' desires to prevent the mobility of the inventors they have trained. *See* Nathan Hamler, *The Impending Merger of the Inevitable Disclosure Doctrine and Negative Trade Secrets: Is Trade Secrets Law Headed in the Right Direction?*, 25 J. CORP. L. 383, 388 (2000) ("[A]t the heart of trade secrets law lies one of the most fundamental policy conflicts that the law and society must deal with: the interests of the employer or business versus the interests of the employee. The law has consistently struggled to draw an acceptable line between these two interests."). In contrast, the tension identified in this Article centers less on inventors' desires for mobility and career advancement and more on inventors' membership in a broader epistemic community of scientists and their shared vision and enthusiasm for the advancement of particular technological frontiers.

47 *See, e.g.*, THE BRITISH INDUSTRIAL REVOLUTION: AN ECONOMIC PERSPECTIVE (Joel Mokyr ed., 1999); Joel Mokyr, *The Institutional Origins of the Industrial Revolution*, *in* INSTITUTIONS AND ECONOMIC PERFORMANCE 64 (Elhanan Helpman ed., 2008).

gins of the Industrial Revolution emphasizes the importance of two factors[48]: First, individual "heroic" inventors, whose creative leaps led to dramatic technological advances;[49] second, the increased availability of patents and legal trade secret protections that allowed these inventors to appropriate the products of their research efforts.[50] But a series of historical studies in key industries during the Industrial Revolution tell a different story.

Robert Allen, in his study of the nineteenth-century blast furnace industry in Cleveland, U.K., was among the first to point out that crucial improvements in furnace efficiency did not emerge from the work of distinct, individual innovators whose efforts were granted patent protection.[51] Rather, Allen coined the term "collective invention" to describe the incremental series of improvements to blast furnaces carried out through the open exchange of information and know-how among competing furnace manufacturers.[52] Indeed, Allen discovered an astonishing degree of information sharing in the blast furnace industry.[53] Surprisingly, information exchange took place not only among established industry players but also included industry entrants.[54] As Allen describes it:

> [I]f a firm constructed a new plant of novel design and that plant proved to have lower costs than other plants, these facts were made available to other firms in the industry and to potential entrants. The next firm constructing a new plant could build on the experience of the first by introducing and extending the design change that had proved profitable. The operating characteristics of this second plant would then also be made available to potential investors.[55]

Information on furnace height and heat capacity, for example, was made available both through informal disclosure and publication in trade (engineering) literature.[56] Notable in this process of information disclosure was the ubiquity of know-how sharing, which took place through frequent visits to competitor's factories to collect data on furnace design and efficiency.[57] Blast engineers also frequently published their data in trade publi-

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48 *See, e.g.*, T.S. ASHTON, THE INDUSTRIAL REVOLUTION (1958).

49 *See generally* James Bessen & Alessandro Nuvolari, *Knowledge Sharing Among Inventors: Some Historical Perspectives*, *in* REVOLUTIONIZING INNOVATION: USERS, COMMUNITIES AND OPEN INNOVATION (2012); Mokyr, *supra* note 47.

50 *See* Bessen & Nuvolari, *supra* note 49; Mokyr, *supra* note 47.

51 Allen, *supra* note 5, at 2 ("However, if one examines a sector like the blast furnace industry and determines the inventions whose diffusion were important for the growth in efficiency, it proves impossible to attribute their discovery to any single inventor. Certainly, no one received a patent for many of these advances.").

52 *Id.*

53 *Id.* at 6–7.

54 *Id.* at 9.

55 *Id.* at 2.

56 *Id.* at 8.

57 *Id.*

cations, and provided detailed presentations to engineering societies, which served as "forums for the presentation of technical material."[58]

What explains this free exchange of know-how among competitors? Traditional incentive theories of innovation predict either that firms would keep such know-how as a trade secret or protect it with patents. Indeed, under the transactional theories of patents and trade secrets advanced by Bar-Gill, Parchomovsky, Merges, and Arora, it is largely through the legal protection afforded by patents and trade secrets that innovation moves from firms to the market.[59] Allen provides two potential explanations for his observations that deviate from the traditional, transactional view outlined in Section I.A. First, engineers who worked on blast furnaces were part of a small epistemic community that rotated among several ironmasters. Information trading among these engineers may initially have served to advance their "professional ambitions"—signaling their technical expertise to their peers and helping with career advancement.[60] Over time, however, and regardless of the initial reasons for know-how trading, these engineers developed a series of social norms that favored openness and reciprocal information-sharing.[61]

This first explanation is intriguing because engineers may have been acting at cross-purposes with their employing firms. But if this was the case, it is hard to understand why nineteenth-century firms did not oppose such disclosing behavior. Allen's second explanation may help answer this question. Allen postulates that the type of know-how that was exchanged across firm boundaries was incremental in nature. In other words, no single piece of know-how was a game changer that could give its holder a large competitive advantage. As Allen emphasizes:

> Each individual has some cherished bit of knowledge, some trade secret which he hoards carefully. Perhaps by sharing it with others, he *might* impart useful information; but by an open discussion and interchange he would, almost for certain, learn a dozen things in exchange for the one given away. General increase of knowledge would give general improved practice, most likely a larger use of the materials in which a manufacturer is interested.[62]

Nevertheless, there is an implicit tension in the dual role of engineers as both employees of competing organizations and members of an epistemic community interested in the overall advance of a particular technology. As I explain and expand later, this tension continues to be present in modern innovation contexts.

What is clear from Allen's research, however, is that the aggregate *social* impact of the myriad know-how exchanges across individual firms was

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58 *Id.*

59 *See generally* Arora & Merges, *supra* note 33; Bar-Gill & Parchomovsky, *supra* note 33.

60 Allen, *supra* note 5, at 17.

61 *Id.*

62 *Id.* at 19 (quoting Gerard A. Muntz, *The Relation Between Science and Practice and Its Bearing on the Utility of the Institute of Metals*, 1 J. INST. METALS 286, 291 (1909)).

immense. Taken together, these exchanges enabled collective increases in blast furnace height from fifty to eighty feet and in blast temperature from 600 °F to 1400 °F and were crucial for productivity growth in this industrial region.[63]

Allen also notes that firms may have allowed the informal exchange of relevant know-how because "it would have been costly to keep it secret."[64] Specifically, Allen emphasizes the high rate of mobility of engineers in the blast furnace industry, who often shifted quickly from firm to firm. In other words, the structure of the labor market for furnace engineers made it too costly for firms to rely on either self-help *or* trade secret protection to prevent information leakage. On its face, this explanation is puzzling. After all, one of the justifications for having trade secrets is precisely that the legal protection they offer firms *lowers* the costs of keeping information secret. Absent trade secret protection, the theory goes, firms may overinvest in private measures for keeping any valuable information secret. Trade secret law prevents such overinvestment by providing a cause of action against those who misappropriate secret information.[65] This case study thus provides a powerful counterexample to this traditional understanding of trade secret law. It suggests that under some conditions—incremental know-how trading, and an epistemic community with social norms of open-sharing—lack of trade secret protection may lead to openness rather than excessive efforts at secrecy.

But what can an isolated case study about the iron industry in nineteenth-century England tell us about the Industrial Revolution? Quite a lot, it turns out. Despite initial critiques of Allen's study as being unrepresentative of broader trends, a series of more recent studies suggest otherwise.[66] For example, Alessandro Nuvolari's 2004 study of the development of steam technology argues that, "together with individual inventors, collective invention settings were a crucial source of innovation during the early phases of industrialisation."[67] The steam engine engineers described in Nuvolari's study shared information about engine performance much like the engineers in Allen's study. Steam engine engineers published a widely consulted

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63 *Id.* at 3.

64 *Id.* at 17.

65 *See, e.g.*, Mark Lemley, *The Surprising Virtues of Treating Trade Secrets as IP Law*, 61 STAN. L. REV. 311 (2008); *see also infra* Section II.A.

66 *See, e.g.*, ROBERT C. ALLEN, THE BRITISH INDUSTRIAL REVOLUTION IN GLOBAL PERSPECTIVE (2009) (describing improvements in coal burning houses in seventeenth century London as instances of collective innovation); CHRISTINE MACLEOD, INVENTING THE INDUSTRIAL REVOLUTION: THE ENGLISH PATENT SYSTEM, 1660–1800, at 113 (1988) (describing collective innovation as a key driver in clock and instrument-making); Robert Allen, *The Industrial Revolution in Miniature: The Spinning Jenny in Britain, France and India*, 69 J. ECON. HIST. 901 (2009) (describing improvements to the spinning jenny as a process of collective innovation); Bessen & Nuvolari, *supra* note 49 (synthesizing historical studies on collective innovation); Lamoreaux et al., *supra* note 2, at 417 (describing episodes of collective innovation in Philadelphia's textile sector); Nuvolari, *supra* note 5.

67 Nuvolari, *supra* note 5, at 349.

technical bulletin.[68] And they informally revealed information to each other about engine performance. Steam engineers were also part of an epistemic community with high labor mobility: because engineers were recruited on a one-off basis, they often worked in many of the firms in that geographic area.[69] Nuvolari hypothesizes that publication in the technical bulletin also served to "signal their talents hence improving career prospects."[70] And these disclosures did not disadvantage their employers. To the contrary, because the technology at issue was complex and engineers shared small, incremental pieces of information, this type of know-how sharing allowed the "pooling [of] all accumulated experience . . . focus[ing] the search process on the most promising directions."[71] Other case studies of key technological innovations, such as steamboats, textile machinery, and airplanes, in both Europe and the Americas, have revealed additional instances of "collective innovation."[72]

In all of the industries that were the subject of these historical case studies, innovation took place precisely in the spaces of intersection between distinct firm knowledge. Historians of technology often contrast this early system of "collective innovation" with the system of large corporate R&D laboratories that emerged in the early and mid-twentieth-century.[73] The rise of the corporate laboratory as the locus of innovation was thought to have eclipsed collective innovation models. More recent empirical studies on innovation, however, reveal the resurgence of "collective efforts by networks of inventors, distributed across organizations and spanning distant locations."[74] The next Section fast-forwards to present-day innovation, synthesizing empirical studies in biotechnology and other industries where knowledge networks continue to play an increasingly crucial role in innovation.

C. *Innovation Networks: Empirical Studies*

Changes in technological innovation—most notably increasing knowledge specialization coupled with the increasing complexity of innovations—have led to what some researchers term a "second wave" of collective innovation.[75] For example, empirical studies on knowledge flows in the biotechnology industry reveal that the two most prolific biotechnology clusters in the United States, the Bay Area and Boston clusters, are characterized by high knowledge-flows among competing start-up firms.[76] Knowledge sharing is

68 *Id.* at 357.

69 *Id.*

70 *Id.*

71 *Id.* at 356.

72 *See, e.g.*, Lamoreaux et al., *supra* note 2, at 417 (describing episodes of collective innovation in Philadelphia's textile sector).

73 *See, e.g.*, CHANDLER, *supra* note 30; LESLIE HANNAH, THE RISE OF THE CORPORATE ECONOMY (1976).

74 Powell & Giannella, *supra* note 2, at 1.

75 *Id.* at 5 (dating the origin of this "second wave" to the 1980s).

76 Powell et al., *supra* note 2.

also considered a crucial element in software development in these two regions.[77] Eric von Hippel has also documented instances of modern informal information-sharing by engineers working in mini-mills.[78]

Walter Powell and Eric Giannella have suggested that we define this modern version of collective innovation as "technological advance driven by knowledge sharing among a community of inventors who are often employed by organizations with competing intellectual property interests."[79] This Article adopts Powell's definition, as it highlights the fundamental puzzle of collective innovation: What incentivizes actors with competing intellectual property interests to share crucial know-how?

No single factor explains this second wave of collective innovation. Rather, a series of factors that includes characteristics of both inventor communities and the inventions themselves makes collective innovation more likely. The inventor community qualities that promote information sharing have been identified as follows. Individual innovators working within a firm may reveal firm-specific know-how to other innovators who are part of their

77 The Silicon Valley and Boston regions have been the subject of detailed historical and network-analytic studies for two "periods" of technological development in two distinct technology areas: the explosion of the electronics industry in the late 1970s, and the emergence of biotechnology in the late 1980s. *See, e.g.*, PONTUS BRAUNERHJELM & MARYANN P. FELDMAN, CLUSTER GENESIS: TECHNOLOGY-BASED INDUSTRIAL DEVELOPMENT (2007); ANNALEE SAXENIAN, REGIONAL ADVANTAGE: CULTURE AND COMPETITION IN SILICON VALLEY AND ROUTE 128 (1996); Lee Fleming et al., *Why the Valley Went First: Aggregation and Emergence in Regional Inventor Networks*, *in* THE EMERGENCE OF ORGANIZATIONS AND MARKETS, *supra* note 8, at 520; Powell & Giannella, *supra* note 2; AnnaLee Saxenian, *Inside-Out: Regional Networks and Industrial Adaptation in Silicon Valley and Route 128*, 2 CITYSCAPE: J. POL. & RES. 41 (1996). In traditional economic analyses of innovation, these two regions are routinely identified as "regional clusters." Such clusters are predicted to enjoy greater economic productivity by taking advantage of "external economies of scale"—factors external to single firms that provide economic benefits to the entire region. Specifically, regional clusters prosper because of both knowledge spillovers across firms and the easier availability of a large skilled labor pool, specialized suppliers, and other specialized infrastructure and services. *See, e.g.*, PAUL KRUGMAN, GEOGRAPHY AND TRADE (1991); MICHAEL PIORE & CHARLES SABEL, THE SECOND INDUSTRIAL DIVIDE: POSSIBILITIES FOR PROSPERITY (1984); Brett M. Frischmann & Mark A. Lemley, *Spillovers*, 107 COLUM. L. REV. 257 (2007); Paul Krugman, *Increasing Returns and Economic Geography,* 99 J. POL. ECON. 483 (1991). Network analyses of regional clusters focus on understanding how social and technical networks among both firms and inventors influence economic productivity by influencing knowledge flows across firms. *See, e.g.*, Fleming & Frenken, *supra* note 8; Powell & Giannella, *supra* note 2; Saxenian, *supra*.

78 *See* von Hippel, *supra* note 5, at 294. As was the case with know-how exchange in the Industrial Revolution, this exchange was incremental, with each piece of know-how having "only a small individual impact on production costs . . . , [but a large] collective impact." *Id.* In von Hippel's study the type of information that was exchanged across the informal network was regulated by social norms among engineers themselves. Engineers made "a judgment as to the competitive value of the information [another engineer was] requesting. If it seems to him vital to his own firm's competitive position, he will not provide it." *Id.* at 292.

79 Powell & Giannella, *supra* note 2, at 4.

epistemic community, but who are nonetheless working for competing firms.[80] Individuals are motivated to disclose know-how both for career advancement reasons (that is, to signal their deep expertise) and when they are personally invested in seeking advances in a new technological frontier.[81] These individual incentives to disclose are often reinforced by their belonging to epistemic communities of innovators that cut across individual firm boundaries and favor open information sharing.[82] For example, studies on the Boston and Bay Area biotechnology clusters show that innovators involved in biotechnology and pharmaceutical companies belonged to epistemic communities of biologists anchored in research universities. In these two clusters, norms of openness and collaboration—characteristic of basic university research—migrated (albeit in attenuated forms) to the private realm.[83]

In addition, technologies where collective innovation has been observed share certain characteristics. They tend to be fast-moving and to require the combination of deep expertise in multiple technical domains.[84] Because knowledge in these complex, emerging fields is increasingly fragmented and specialized, it is hard for individual firms to remain abreast of developments in these fields, and to host all the necessary expertise in-house.[85] In these industries, collective innovation may emerge as an efficient strategy to access relevant (and often complementary) information.[86] Further, these complex areas of innovation are often highly uncertain.[87] Participation in collective efforts lowers the risk of failure for each party involved—acting as a form of insurance.[88]

Finally, in any new, complex technology there are several "bottleneck" steps that impact the viability and the direction of the technology, but whose benefits are hard for a single party to appropriate. Examples of this type of

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80 *See, e.g.*, Fleming et al., *supra* note 77; Powell & Giannella, *supra* note 2, at 19 ("Cultures of technology are important because they help explain the continuity of an underlying technical community despite temporal shifts in organizing for collective invention versus private R&D.").

81 *See, e.g.*, Powell & Giannella, *supra* note 2, at 3 ("Many technological systems reflect a confluence of uncoordinated research efforts driven by intense and widespread interests that intersect around the development of a novel technology.").

82 *See, e.g.*, Brad K. Wray, *The Epistemic Significance of Collaborative Research*, 69 PHIL. SCIENCE 150 (2002) (arguing that the increasing dependence of technical personnel on common equipment socializes scientists and engineers into norms of collective work).

83 For example, Powell, Packalen & Whittington, *supra* note 8, explain how "[b]oth Genentech and Chiron adopted and refined UCSF's team model, insisting that their scientists publish in academic journals, but added the impatience of venture capital financial backers with their focus on swinging for the fences." *Id.* at 447.

84 *See, e.g.*, Dahl & Pedersen, *supra* note 8; Gulati, *supra* note 43; Powell & Giannella, *supra* note 2; James Bessen & Alessandro Nuvolari, *Knowledge Sharing Among Inventors: Some Historical Perspectives* (Boston Univ. Sch. Law Working Paper No. 11–51, 2011).

85 See sources cited *supra* note 84.

86 See sources cited *supra* note 84.

87 See sources cited *supra* note 84.

88 See sources cited *supra* note 84.

bottleneck step include exploratory research to find new problems at the intersection of multiple fields, and research that reduces the overall uncertainty of carrying out particular types of interdisciplinary research.[89] In traditional models of intellectual property, this inability to appropriate the products of exploratory or uncertainty-reducing research is predicted to lead to a market failure: despite the overall social benefits of the research, no individual firm would be incentivized to carry it out. One traditional response to this type of market failure is to increase the strength of intellectual property rights, or to directly subsidize exploratory research.[90] Under this traditional paradigm, stronger trade secrets or patent rights, by increasing appropriability, would increase the incentives for a single firm to engage in risky exploratory research. Paradoxically, empirical studies on this type of complex technology demonstrate that firms will sometimes self-organize into collective innovation clusters to solve this appropriability problem.[91] In other words, open-sharing rather than increased intellectual property protection can be the key to addressing bottlenecks in complex innovation.

Studies of biotechnology clusters suggest that successful clusters[92] have strong "anchor tenants"—well-connected organizations that help broker local relationships with diverse players, including venture capital, start-ups, and established pharmaceutical companies.[93] Successful biotechnology clusters in Boston, the San Francisco Bay Area, and San Diego also established early governance systems that provided an "interactional template" to promote collective innovation.[94] As a result all three clusters are characterized by a high degree of interfirm collaboration among competitor biotech companies.[95]

89 *See, e.g.*, Winter Mason & Duncan J. Watts, *Collaborative Learning in Networks*, 109 PNAS 764 (2012).

90 *See, e.g.*, Richard Nelson, *The Simple Economics of Basic Scientific Research*, 67 J. Pol. Econ. 297 (1959).

91 *See, e.g.*, Lamoreaux et al., *supra* note 2; Powell, *supra* note 2; Powell et al., *supra* note 2; Powell & Giannella, *supra* note 2.

92 *See* Powell, Packalen & Whittington, *supra* note 8, at 434, 451.

93 *Id.* at 459.

94 Powell & Giannella, *supra* note 2, at 21–22.

95 The Emergence of Organizations and Markets, *supra* note 8, at 376 (The authors identify "three crucial factors: organizational diversity; anchor tenant organizations that protect the norms of a community and provide relational glue across multiple affiliations; and a sequence of network formation that starts with local connections and subsequently expands to global linkages."). The studies cited in this Section for the biotechnology and IT industries rely on patent co-authorship, licensing agreements, and R&D collaborations to graph the network of relationships among different players (including their social distance), to identify inventor clusters, and to trace how these networks change over time. The resulting network captures both formal and informal relationships. Several of the studies cited in this Section rely also on key informant interviews, surveys, or participant observations to round out information regarding the nature of information flows (formal vs. informal) within each cluster. *See* Powell, Packalen & Whittington, *supra* note 8 (graphing relationships in several biotechnology clusters based on R&D agreements, licensing agreements and financing deals); *see also* Fleming et al., *supra* note 77 (analyzing inventor

One of the most interesting observations regarding these successful clusters is the extent to which social norms from each realm (private business and universities) were recombined and transposed across private-public boundaries—a factor particularly salient in Silicon Valley clusters. Private biotech firms in the Bay Area "adopted academic norms of publishing and collaboration and repurposed them into the world of commerce through extensive affiliations with other biotech companies and universities."[96] All the while, Stanford (the area's "anchor tenant") embraced the academic entrepreneurship model.[97] In turn, the success of San Diego start-ups was due in large part to the strong networks of information-exchange among employees. These networks were established somewhat serendipitously: most founders of San Diego start-ups had previously worked at a failed diagnostics-focused company (Hybritech), which had been acquired by Eli Lilly.[98] After Hybritech's failure, former employees remained in the San Diego area, founded the second-generation San Diego start-ups, and "created a context in which job mobility and information sharing took place"[99] by collaborating with each other and with scientists at the multiple research institutes and universities in the area.[100]

When comparing successful and failed clusters, researchers found that the most important difference between them was the absence, in the failed group, of thick *local* relational ties that fostered the recombination of social norms, information-sharing, and joint problem solving.[101] For this reason, researchers hypothesize that the creation of a culture of open-sharing in successful clusters required *local* social ties, in addition to a background epistemic community with shared social norms.[102] In the case of successful

network using co-authored patents with a five year moving window, and key informant interviews); Amalya L. Oliver & Julia Porter Liebeskind, *Three Levels of Networking for Sourcing Intellectual Capital in Biotechnology: Implications for Studying Interorganizational Networks*, 27 INT'L STUD. MGMT. & ORG., no. 4, 1997, at 76 (interview studies); Kjersten Bunker Whittington, Jason Owen-Smith & Walter W. Powell, *Networks, Propinquity, and Innovation in Knowledge-Intensive Industries*, 54 ADMIN. SCI. Q. 90 (2009) (R&D and licensing contract data).

96 Powell, Packalen & Whittington, *supra* note 8, at 449.

97 *See generally* Jeannette A. Colyvas, *From Divergent Meanings to Common Practices: The Early Institutionalization of Technology Transfer in the Life Sciences at Stanford University*, 36 RES. POL. 456 (2007).

98 Powell, Packalen & Whittington, *supra* note 8, at 449.

99 *Id.* at 450.

100 *Id.*

101 *Id.* at 451 ("In contrast to the successful clusters, [in failed clusters] local ties are rather sparse. The bulk of collaboration occurs with partners outside the regions, suggesting that local knowledge exchange and interorganizational labor mobility are rather limited."). "Failed clusters" were those located in "the broader New York metropolitan area, northern New Jersey, the Philadelphia metropolitan area, the Washington, D.C. metro area, the Research Triangle in North Carolina, Houston, Seattle, and the Los Angeles metro area." *Id.* at 450.

102 *Id.* at 451

clusters, thick local ties eventually expanded globally.[103] The reverse was not the case: failed clusters that began with external ties never developed thick local relationships.[104] It is precisely through the local exchange and recombination of information and know-how that biotechnology clusters flourished and expanded.

The importance of local informational exchange for cluster success raises an important follow-up question: Precisely what type of information is exchanged informally across firm boundaries? Several case studies suggest that the know-how exchanged in the industries where this behavior has been documented is "incremental."[105] In fact, one study defines technical know-how precisely as an incremental piece of secret information that, in isolation, is "not vital to a firm" and "can be independently developed by any competent firm needing it, given an appropriate expenditure of time and money."[106]

Of course, some pieces of technical know-how can result in major competitive advantages, either because of the timing of its discovery in a fast-paced industry or because it cannot be routinely reinvented. In the industries where informal know-how exchanges have been documented, however, there appears to be a conscious self-monitoring on the part of employee-inventors regarding which pieces of technical know-how to share and which ones to keep secret that tracks the commercial value of the information.[107] As Eric von Hippel describes: "B makes a judgment as to the competitive value of the information A is requesting. If it seems to him vital to his own firm's competitive position, he will not provide it."[108] This finding is not too surprising. After all, despite assertions about basic scientific communities' commitment to openness, secrecy is quite common in epistemic communities of scientists. In fact, employee-inventors are likely transposing similar filters regarding which information to reveal and which to keep secret that pervade basic scientific research.[109]

Finally, informal know-how exchange through epistemic networks will only be sustainable if there are strong social norms that favor reciprocity and that punish lack of cooperation. Each individual inventor may be continuously tempted to defect, because she will receive higher returns by defecting if her trading partner continues to behave cooperatively. Enforcement

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103 *Id.* at 457.

104 *Id.*

105 Allen, *supra* note 5; von Hippel, *supra* note 5. Two types of incremental know-how appear to be frequently exchanged through informal networks: 1) "negative know-how" or knowledge about what does *not* work to solve a problem, and 2) knowledge about how to successfully perform publicly available protocols. *Id.*

106 Von Hippel, *supra* note 5, at 298; *see also* Schrader, *supra* note 8, at 165.

107 *See, e.g.*, Rogers, *supra* note 8, at 114; Schrader, *supra* note 8, at 165; von Hippel, *supra* note 5, at 292.

108 Von Hippel, *supra* note 5, at 292.

109 *See, e.g.*, John P. Walsh & Wei Hong, *Secrecy Is Increasing in Step with Competition*, 422 NATURE 801 (2003); Koen Vermeir & Dániel Margócsy, *States of Secrecy: An Introduction*, 45 BR. J. HIS. SCI. 153 (2002).

appears to take place through negative reputational effects that reduce others' willingness to share information in the future. Indeed, interviews suggest that researchers at biotechnology firms are sensitive to the negative reputational repercussions of failing to share reciprocally.[110]

The studies synthesized above contrast areas where productive clusters formed (Boston, Silicon Valley, and San Diego) with those where regional clusters failed to emerge. In a frequently cited study, AnnaLee Saxenian compared the productivity of the Boston and Silicon Valley clusters themselves. Saxenian argued that the different productivities of the two regions—with Boston losing its place to Silicon Valley as the dominant player in information technology—can be explained in part by the differences in social network structures between the two regions.[111] Silicon Valley, with its "[l]oosely linked team structures [that] encourage[d] horizontal communication among firm[ ] divisions and with outside suppliers and customers,"[112] gained a competitive edge against autarkic and secretive Boston firms that discouraged outside collaboration.[113] But more recent analyses have cast some doubts on this narrative.[114] Although Boston's preeminence as a center for IT research declined, it has re-emerged as a center for biotechnology research.[115] Network research mapping social relationships among inventors across firms shows that the *inventors*' social networks in both regions are remarkably similar.[116] So are their motivations for engaging in informal information-sharing.[117] Further, while firms in Silicon Valley were more likely to allow information-sharing across firm boundaries, the most salient finding in subsequent research studies is that of an enduring tension *in both*

110 *See* Oliver & Liebeskind, *supra* note 95, at 86 (quoting a research scientist at a biotechnology firm: "[Biotechnology firms] have gained the reputation that they try to get information out of university researchers, but do not share their own work in return. As a result, at international conferences, university professors avoid talking with us. This is our opportunity to help some university scientists, in exchange for some unspecified returns from them. In the long run, the company benefits.").

111 Saxenian, *supra* note 77, at 41–42.

112 *Id.* at 45.

113 *Id.* This reasoning is in line with other research pointing to the importance of relaxed enforcement of legal proscription of noncompete covenants. *See, e.g.*, Angel, *supra* note 8; Gilson, *supra* note 27.

114 *See* Jonathan M. Barnett & Ted Sichelman, *Revisiting Labor Mobility in Innovation Markets* (USC Legal Studies Research Papers Series No. 16-15, 2016), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2758854.

115 *See, e.g.*, Fleming et al., *supra* note 77, at 521.

116 *See, e.g.*, *id.* at 538 ("The analyses suggested that the Valley's greater degree of aggregation was not caused by a fundamental difference in the microsocial structure of its collaborative network. Indeed, the analyses . . . indicated that the top six components of the two regions were quite similar, with the exception that the GTE/Siliconix component was more densely networked than its Valley counterpart.").

117 *See id.*

regions between managers and inventors regarding the desirability of information flow.[118]

This tension between firms' (or managers') and inventors' attitudes towards information flow has important consequences for trade secret theory and doctrine that have not been explored in the legal literature. The next Part begins this conversation. It analyzes how focusing on knowledge networks as loci of innovation in complex and emerging fields should impact trade secret theory and doctrine, paying particular attention to how trade secret law affects *both* inventor and firm incentives to disclose information.

II. Implications for Trade Secret Law Theory

A. *Utilitarian Theories of Trade Secret Protection*

Trade secret law sits uncomfortably among the core intellectual property regimes of copyright and patent law. The primary justification for both copyright and patent law is utilitarian: these two regimes are needed to incentivize creativity and innovation.[119] But trade secrets do not fit neatly within this incentive story. Indeed, legal scholars as well as treatise and restatement writers have alternately classified trade secrets as belonging to tort and contract law—in addition to intellectual property law.[120] Do trade secrets serve to preserve commercial ethics, and thus properly belong to tort law? Or is trade

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118 *See id.* ("We are struck by the bi-modal distribution of attitudes on the issue [of information flows], mainly along professional lines and independent of the region. Most of the inventors from both regions expressed similar laissez-faire, open, and positive attitudes toward information flow. Many of their stories described an effort to evade efforts by management to contain their boundary-crossing collaborations."). Other studies have found a similar tension. *See, e.g.*, Sharon Mollman Elliott, *The Threat from Within: Trade Secret Theft by Employees*, 25 Nature Biotech. 293, 293 (2007); Oliver & Liebeskind, *supra* note 95, at 86 (noting that managers had given their inventors "clear instructions not to" share information with other firms, but that such sharing nonetheless took place); von Hippel, *supra* note 5, at 296 ("Interestingly, however, trading seems a more quasi-covert, secretive activity by engineering staffs in some of these industries than was the case in steel minimills."); Emily Waltz, *Under Wraps*, 27 Nature Biotech. 880 (2009); Susan Wright & David A. Wallace, *Varieties of Secrets and Secret Varieties: The Case of Biotechnology*, 19 Pol. & Life Sci. 33 (2000).

119 *See, e.g.*, Peter S. Menell, *Intellectual Property: General Theories*, *in* Encyclopedia of Law & Economics, Volume II. Civil Law and Economics 129 (Boudewijn Bouckaert & Gerrit De Geest eds., 2000).

120 *See, e.g.*, William M. Landes & Richard A. Posner, The Economic Structure of Intellectual Property Law 355 (2003) (Because remedies for breach of trade secrets are defined by common law principles "without regard to trade secrets or to information in general . . . in a sense there is no law of trade secrets."); Robert G. Bone, *A New Look at Trade Secret Law: Doctrine in Search of Justification*, 86 Calif. L. Rev. 241, 243 (1998) (The author argues that "trade secret liability should be governed mainly by contract principles."); Jerome H. Reichman, *How Trade Secrecy Law Generates a Natural Semicommons of Innovative Know-How*, *in* The Law and Theory of Trade Secrecy: A Handbook of Contemporary Research, *supra* note 5, at 185; Michael Risch, *Why Do We Have Trade Secrets?*, 11 Marq. Intell. Prop. L. Rev. 1, 3 (2007) ("Trade secrets are curious anomalies in intellectual property law."); Michael Risch, *Trade Secret Law and Information Development*

secret law simply concerned with enforcing (sometimes implicit) contractual agreements between employers and employees, and thus the province of contract law? In view of this doctrinal confusion, some scholars have called for the abolition of trade secret law altogether.[121] A second group of scholars, however, has developed a utilitarian, incentives-based view of trade secret law, which has become the predominant view of innovation scholars.[122] This Part argues that understanding complex innovation as emerging out of networks of informal information-sharing across firms calls into question this incentives story in the context of complex innovation.

Utilitarian theory posits that trade secrets incentivize innovation in two ways. According to the first, the "gap filler" function of trade secrets is grounded on the ability of trade secrets to incentivize the production of types of information not protected by patent law.[123] According to the second, trade secret protection functions to prevent excessive (and thus inefficient) private investment in self-help measures to keep information secret.[124]

Landes & Posner examined when a rational inventor would choose trade secret protection over patent law.[125] They argue that trade secrets are preferable to a rational inventor when patent protection is too costly in relation to the value of his or her invention.[126] Obtaining a patent involves a lengthy application process before the U.S. Patent and Trademark Office (USPTO).[127] Because the USPTO publishes all patent applications eighteen months after filing, a patent applicant also runs the risk of being denied patent protection but nonetheless having made available to the public important information contained in his or her application.[128] This risk is obviously more salient for inventions that are likely not patentable.[129] But a rational innovator may choose trade secrecy even for clearly patentable innovations when the cost of patenting (including the disclosure requirements) exceeds

Incentives, *in* THE LAW AND THEORY OF TRADE SECRECY: A HANDBOOK OF CONTEMPORARY RESEARCH, *supra* note 5, at 152.

121 *See* Bone, *supra* note 120, at 245–46 ("I propose that we stop seeking a functional justification for trade secret law and recognize this body of law for what it really is—a collection of other legal wrongs."); *see also* LANDES & POSNER, *supra* note 120, at 355 (The authors argue that "in a sense there is no law of trade secrets.").

122 *See, e.g.*, Lemley, *supra* note 65, at 313; W. Nicholson Price II, *Making Do in Making Drugs: Innovation Policy and Pharmaceutical Manufacturing*, 55 B.C. L. REV. 491, 532–39 (2014); W. Nicholson Price II & Arti K. Rai, *Manufacturing Barriers to Biologics Competition and Innovation*, 101 IOWA L. REV. 1023, 1044–50 (2016); Risch, *Why Do We Have Trade Secrets?*, *supra* note 120, at 5–6.

123 *See* Lemley, *supra* note 65, at 326.

124 *See id.* at 340.

125 LANDES & POSNER, *supra* note 120, at 356–57.

126 *See id.* at 357.

127 *See, e.g.*, David Popp, Ted Juhl & Daniel K.N. Johnson, *Time in Purgatory: Examining the Grant Lag for U.S. Patent Applications*, 4 TOPICS ECON. ANALYSIS & POL'Y, no. 1, 2004, at 1.

128 *See* 35 U.S.C. § 122 (2012) (confidential status of applications; publication of patent applications).

129 *See* LANDES & POSNER, *supra* note 120, at 358.

the projected value of the innovation.[130] In this context, trade secrets serve the "gap filling" role of protecting commercially valuable but unpatentable information, as well as patentable information that is too costly to patent—for example in fast moving industries where the length of time to obtain a patent makes patent protection impractical.[131]

What, then, would happen if trade secret law was unavailable to this rational innovator? First, firms may inefficiently over-invest in self-help measures to ensure secrecy.[132] In the absence of a legal remedy against trade secret misappropriation, Landes and Posner hypothesize, "employers might be led to reorganize their businesses in a manner that might be grossly inefficient were it not for the imperative of secrecy."[133] The Supreme Court in *Kewanee Oil Co. v. Bicron Corp.*[134] made a similar argument in favor of trade secret protection. In *Kewanee Oil*, the Court predicted that abolishing trade secret protection would lead to "an increase in the amount of self-help that innovative companies would employ."[135] By providing a legal remedy for the misappropriation of secret information, trade secret law serves as a substitute for excessive private efforts to ensure the security and inaccessibility of secret information.[136]

Second, the Court in *Kewanee Oil* also predicted that abrogation of trade secret protection would lead to the dispersion of knowledge among employees and to the fragmentation of "organized scientific and technological research" to the detriment of society as a whole.[137] Such knowledge dispersion, the Court postulated, would arise from the reluctance of employers to disclose fully important firm information to any but the most trusted employees.[138] In this context, trade secret law is thought to serve an important

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130 *See id.* at 357.

131 *See id.* at 359; *see also* Lemley, *supra* note 65, at 326. Of course, a rational innovator would also choose to keep an innovation secret when he or she thinks that he or she has a very good chance of maintaining secrecy for a sufficiently long period of time. But we are less concerned about this third type of innovation: trade secret law is unlikely to have an incentive effect on those innovations that are easy to keep secret using private means.

132 *See* LANDES & POSNER, *supra* note 120, at 364.

133 *Id.*

134 416 U.S. 470 (1974).

135 *Id.* at 485–86.

136 *See, e.g.*, Lemley, *supra* note 65, at 313 ("Trade secret law develops as a substitute for the physical and contractual restrictions those companies would otherwise impose in an effort to prevent competitors from acquiring their information.").

137 *Kewanee Oil*, 416 U.S. at 486.

138 *Id.* ("The innovative entrepreneur with limited resources would tend to confine his research efforts to himself and those few he felt he could trust without the ultimate assurance of legal protection against breaches of confidence."); *see also* Fisk, *supra* note 27, at 476 ("The Du Pont company's difficulties with competitors trying to learn its methods by recruiting away its employees may have prompted it to take even more care to exclude strangers from its mills."); David D. Friedman, William M. Landes & Richard A. Posner, *Some Economics of Trade Secret Law*, 5 J. ECON. PERSP. 61, 67 (1991) (arguing that failure to enforce trade secrets against employees may lead employers to "reorganize their businesses in inefficient forms—perhaps by splitting up tasks among more employees so that each

internal coordinating mechanism: fostering efficient information disclosure to inventors within a firm. This is the type of function for intellectual property law analyzed both by Heald and Burk, and described in Part I.[139]

A third postulated consequence of weak trade secret protection is an underinvestment in employee training. Trade secret protection of business know-how incentivizes firm investment in employee training by making it more likely that firms will be able to recoup the costs of such training through employee productivity. As a consequence, employers will either decline to hire the employee or choose to hire him or her but underinvest in his or her training.[140]

B. How Knowledge Networks Research Impacts Utilitarian Theories of Trade Secret Law

To synthesize the arguments presented above, utilitarian theories of trade secret protection predict the following three inefficient outcomes will ensue from lack of trade secret protection: (1) inefficient overinvestment in self-help measures; (2) fragmentation of scientific and technological research; and (3) underinvestment in employee training. These conclusions are based on predictions about how a rational firm may behave, and on balancing the predicted social costs against the benefits of enforcing secrets. The social costs include reduced information flow across firms, and the social benefits include the elimination of the three inefficient outcomes listed above.

But studies on collective innovation and knowledge networks show that in some contexts these social costs are grossly exaggerated. Instead, in complex and fast-moving industries characterized by cross-cutting epistemic communities, low or no trade secret protection is likely to lead to the formation of innovation networks—rather than an increase in inefficient defensive maneuvers.[141] In other words, in industries where knowledge networks are likely to form, the social benefits of information sharing likely outweigh the benefits of enforcing secrecy through (strong) trade secret law. Below, I analyze in more detail how knowledge networks and the tension between manag-

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knows less, or by bringing in family members (even though they may be less competent) as employees, counting on them to be loyal out of altruism or because the family setting often enables effective, informal retaliation against the disloyal"); *cf.* Elliott, *supra* note 118; Robert P. Merges, *The Law and Economics of Employee Inventions*, 13 HARV. J.L. & TECH. 1 (1999).

139 *See* Burk, *supra* note 33; Heald, *supra* note 29; *see also supra* Part I.

140 An employer subject to these potential costs faces two choices. The employer can either decline to hire the employee or hire the employee but underinvest in training and the development and transmission of proprietary information.

141 Indeed, when analyzing whether "reverse engineering" should be considered misappropriation of trade secrets, Friedman, Landes, and Posner argue that because manufacturers learn "things they can put to use in their own design of new products" through reverse engineering, and because the cost of enforcing secrecy through the legal system is high, "[i]n the case of reverse engineering . . . the social cost-benefit calculus appears to favor denial of legal protection." Friedman, Landes & Posner, *supra* note 138, at 67.

ers and inventors' incentive structures influence each of the three benefits of trade secret protection previously identified in the literature.

1. Inefficient Overinvestment in Self-Help Measures

Knowledge networks research suggests that, when it is hard to keep information secret, some industries will build information-sharing innovation networks—rather than higher walls to protect their secrets.[142] For example, when faced with difficulties keeping their inventions secret, steel and coal industries formed innovation clusters.[143] In these clusters, epistemic communities of engineers freely shared some technical know-how across industry boundaries. Rather than weakening individual firm productivity, such information sharing led to episodes of collective innovation in which small, incremental innovative steps led to massive increases in aggregate productivity.[144] Similarly, the rise of biotechnology owes much to free, informal know-how sharing across private-private and private-public boundaries. Biotechnology clusters in Silicon Valley, Boston, and San Diego, for example, were more successful than biotechnology ventures in other major cities precisely because employees shared information across firm boundaries, and across the public-private divide.[145]

Information-sharing networks do not, however, consistently appear when trade secret protection is low or non-existent. Indeed some empirical studies have reached the opposite conclusion. For example, Mark Lemley has further developed and expanded the incentive theory of trade secrets.[146] Lemley agrees with Landes and Posner that trade secret law prevents over-investment in keeping information secret.[147] Lemley bolsters his argument by citing to empirical evidence of the "draconian limits on the mobility of employees and the development of competing firms" imposed by the guild system, and of high investment in self-help measures in countries that do not provide protection for trade secrets.[148]

The problem, then, is to figure out which contexts create innovation networks and which give rise to wasteful self-help efforts. Taken together, knowledge network studies show that lack of trade secret protection will lead

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142 *See supra* Sections I.A, I.B.

143 *See* Allen, *supra* note 5; Nuvolari, *supra* note 5.

144 *See* Allen, *supra* note 5, at 2–3; Nuvolari, *supra* note 5, at 348–49.

145 *See* Philip Cooke, *Biotechnology Clusters as Regional, Sectoral Innovation Systems*, 25 INT'L REGIONAL SCI. REV. 8, 8 (2002) (discussing how "[b]iotechnology is a knowledge-driven sector" which results in "firms cluster[ing] in proximity to knowledge sources"); Philip Cooke, *Regional Innovation Systems: General Findings and Some New Evidence from Biotechnology Clusters*, 27 J. TECH. TRANSFER 133, 133 (2002) (showing that "regional and external innovation interaction among firms and other innovation organizations is important for regional innovation potential"); *see also supra* Section I.B.

146 *See* Mark A. Lemley, *The Surprising Virtues of Treating Trade Secrets as IP Rights*, 61 STAN. L. REV. 311, 329–38 (2008).

147 *See* Lemley, *supra* note 65, at 334.

148 *Id.*

to openness rather than to excessive efforts at secrecy when the following conditions have been met: (1) the innovation at issue is complex (where technological progress is rapid and knowledge is widely dispersed among firms); and (2) the innovators belong to a background epistemic community with social norms of open-sharing (often affiliated with a university that anchors a technology cluster) and share local social ties.

One important counterargument to the prescription to weaken trade secret protection in these industries must be addressed first: If certain industries tend to form innovation clusters instead of relying on self-help measures in the absence of trade secrets, would it not make little difference to those industries whether trade secrets are available? In other words, one could argue that trade secrets have no effect in industries that are likely to form networks, while a positive, innovation-enhancing effect in other industries where lack of trade secret protection is likely to result in wasteful self-help efforts. As a consequence, the argument goes, research on knowledge networks can tell us little about how to design trade secret law. But this argument is misguided. The availability and strength of trade secret protection will invariably alter the calculus of firms when deciding whether to allow or prevent information sharing by their employees, and may tip the balance towards secrecy.

Recall that both historical and empirical studies on knowledge networks show an underlying tension between managers' and inventors' background social norms and incentives regarding informal know-how sharing.[149] Quite remarkably, in each one of the case studies surveyed above—both during the Industrial Revolution and in modern biotechnology and software engineering clusters—the scientists involved directly in innovation belonged to epistemic communities that crossed firm boundaries and favored open sharing.[150] In both historical and present-day innovation clusters, innovators engaged in informal information sharing in no small part because they held a joint interest in advancing a technological frontier.[151] When inventors are part of epistemic communities whose social norms favor openness and information sharing, and instill in their members individual interests in the overall advancement of a particular technological frontier, inventors within individual firms have a tendency for reciprocal informational exchange across firms.

In contrast, managers preferred trade secrets to protect technological know-how, even when reciprocal sharing may well have been to the advantage of their individual firms.[152] These historical and empirical studies

149 *See supra* Sections I.B, I.C.

150 *See* Allen, *supra* note 5, at 16–21 (discussing the development of epistemic communities during the Industrial Revolution); Powell et al., *supra* note 2, at 117 (discussing collaboration in the field of biotechnology).

151 *See* Powell & Giannella, *supra* note 2, at 5.

152 In the aggregate, network studies strongly suggest that in complex industries overall productivity and social welfare increases when information is shared *and created* in networks. *See* Allen, *supra* note 5, at 21; Nuvolari, *supra* note 5, at 356–57; Podolny & Page,

report managers' reluctance to share information but do not analyze *why* this may be the case. There are two possible reasons for managers' behavior.

First, managers (and firms) face well-known coordination problems.[153] Although facilitating informal know-how sharing may be in the collective interest of all firms in the region, it is in the interest of any one firm to defect from cooperation, provided all other firms behave cooperatively. Defecting firms will get the benefits of informational spillovers from other firms while succeeding in keeping internally produced information secret. Thus, absent some coordinating mechanism, beneficial collaboration will not take place. Social norms of reciprocal open-sharing and self-monitoring that emerge in epistemic communities in effect provide one such coordinating mechanism. But, from the perspective of managers, this coordinating mechanism, and in particular the myriad informal exchanges among inventors, will be hard to monitor.[154]

Second, research suggests that managers are more likely than inventors to overvalue internally produced information,[155] and to exhibit short-term bias.[156] These preferences are in sharp contrast to inventors' joint interest in the collective success and advancement of a particular technological frontier.[157]

In this context, the strength of trade secret protection will influence whose preferences will win out, with high trade secret protection favoring managers' preferences and low trade secret protection those of inventors.[158]

From a public policy perspective (looking to maximize overall social benefit), however, legal interventions should seek to increase the formation

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supra note 43, at 62–66; Powell et al., *supra* note 2, at 142–43; Wray, *supra* note 82, at 156–58.

153 *See* Pedraza-Fariña, *supra* note 3 (describing instances in which social forces will prevent productive collaboration); Andrew Schrank & Josh Whitford, *The Anatomy of Network Failure*, 29 SOC. THEORY 151, 153 (2011) (analyzing the reasons for network failure). *See generally* Fleming et al., *supra* note 77 (discussing the factors that inhibit the formation of aggregation and regional inventor networks); Gilson *supra* note 27, at 596.

154 Other coordination mechanisms include formal contractual agreements across firm boundaries, such as joint venture or joint R&D agreements. But the relatively small value of any one piece of technological know-how and the difficulties inherent in monitoring know-how transfers make the transaction costs of setting up a formal collaboration for technical know-how exchange very high. *See* von Hippel supra note 5, at 300 ("Informal know-how trading . . . has a lower transaction cost than more formal agreements to license or sell similar information. Transaction costs in informal know-how trading systems are low because decisions to trade or not trade proprietary know-how are made by individual, knowledgeable engineers.").

155 *See, e.g.*, Fleming et al., *supra* note 77, at 521, 539 ("[M]anagement thought we had all these great secrets to conceal; the engineers knew that the value was in collaboration.").

156 *See* David B. Balkin, Gideon D. Markman & Luis R. Gomez-Mejia, *Is CEO Pay in High-Technology Firms Related to Innovation*? 43 ACAD. MGMT. J. 1118 (2000).

157 *See supra* Section I.C.

158 *See, e.g.*, Fleming et al., *supra* note 77, at 538–39 (discussing how "[inventors'] stories described an effort to evade efforts by management to contain their boundary-crossing collaborations").

of knowledge networks (or clusters) in technological frontiers where innovation is complex.[159] In these types of industries, and because of managerial preferences, strong trade secret protection is likely to have just the opposite effect.[160]

To develop this point further, it is helpful to explore the likely effect of strong and weak trade secret protection on the incentive structure of managers, considering also the underlying (and differing) incentive structure of inventors. Two types of scenarios are possible. First, in the "traditional" case often described in utilitarian analyses of trade secret protection, employees are assumed to act purely in their self-interests, which can lead to opportunistic behavior (reflecting typical principal/agent problems).[161] Second, in the cases of successful innovation clusters I have examined in this Article, inventors are embedded in an epistemic community that cuts across individual firms—with norms of reciprocity and open-sharing, and thick local social ties. These inventors also work in complex industries, with fast-moving technological frontiers where relevant knowledge is widely dispersed across firms. Thus, in these successful clusters, inventors have a particular set of incentives that differ from those of managers, but also differ from those of the opportunistic self-interested inventor of the first scenario. In both cases I assume that managers have a preference or bias for keeping internal information secret and for potentially overvaluing internally produced information.

Inventors in innovation clusters are motivated by their epistemic community norms to share information openly and reciprocally with other community members. They are also driven by a personal desire—likely nurtured by epistemic community membership—to solve problems in and advance the frontiers of a particular technological field.[162] Both of these incentives can conflict with manager-specific preferences for keeping internal discoveries secret. But it is the differences between the opportunistic, self-interested inventor and the epistemic-community inventor that will influence the impact of strong trade secret protection on overall social utility.

There are therefore two possible scenarios. In the first scenario, when inventors are not constrained by social norms of reciprocal open-sharing, or by a common interest in advancing a technological frontier, there is a good

159 *See* sources cited *supra* note 120 (emphasizing the overall advantages for technological progress in complex industries of informal knowledge flows through local networks). One potential concern is that knowledge networks, by encouraging firms to pool their resources and share any resulting technology, can ultimately have anti-competitive effects. Concerns about anti-competitive effects, however, are mitigated when firms pool complementary technological know-how, as is often the case in these complex industries. Indeed, antitrust authorities generally find these types of collaborative arrangements pro-competitive. *See* DOJ/FTC ANTITRUST GUIDELINES FOR COLLABORATION AMONG COMPETITORS at 1 ("[C]ollaborations [among competitors] often are not only benign but procompetitive.").

160 *See, e.g.*, ALAN HYDE, WORKING IN SILICON VALLEY: ECONOMIC AND LEGAL ANALYSIS OF A HIGH-VELOCITY LABOR MARKET 27–40 (2003).

161 *See, e.g.*, Kathleen M. Eisenhardt, *Agency Theory: An Assessment and Review*, 14 ACAD. MGMT. REV. 57 (1989).

162 *See* Fleming et al., *supra* note 77, at 539; Powell & Giannella, *supra* note 2, at 5.

argument that strong trade secret protection that prevents informal know-how exchange across firm boundaries can have an overall positive social impact.[163] Managers are likely to rely on and enforce strong trade secret laws to prevent inventors from taking critical know-how with them when departing for competing firms (or from sharing such critical know-how while employed at the firm for personal benefit). As a consequence, inventors will be less likely to engage in this opportunistic behavior to begin with and managers less likely to overinvest in inefficient self-help measures such as enhanced security measures and selective or fragmented disclosure of sensitive information to employees.

In this first scenario—the case of the opportunistic employee-inventor—weak or nonexistent trade secret protection will in turn enhance self-help measures by managers to prevent inventors' likely opportunistic behavior. Crucially, in this first scenario, there is no reciprocal exchange of information, no creation of new knowledge in the process of informal informational exchange and collaboration across firm boundaries, and no clustering of innovation.[164]

In contrast to scenario one, information exchange occurs reciprocally through an epistemic network in scenario two. Network members share the goal of pooling widely dispersed but complementary expertise to solve a complex technological problem or advance a technological frontier. The social gains of such informal information exchange are much clearer, and so are the social costs of preventing it. On balance, therefore, trade secret law should not be deployed to prevent this type of reciprocal information exchange.[165] Let us examine, however, the likely outcome of the availability of either strong or weak trade secret protection in scenario two.

When trade secret protection is strong, managers (who have a preference for maintaining secrecy and eschewing informal information exchanges) are likely to deploy trade secret law to chill the formation of

163 *See, e.g.*, Gillian Lester, *Restrictive Covenants, Employee Training, and the Limits of Transaction-Cost Analysis*, 76 IND. L.J. 49 (2001). *But see* Lobel, *supra* note 27, at 845–46 ("The long-unchallenged assumption has been that human capital controls are necessary because otherwise employers would underinvest in employee training. In other words, the move toward cognitive property is necessary to incentivize corporate investment. Under the traditional analysis, externalities are a type of market failure. Just as tort liability aims to internalize negative externalities—the harm to others—knowledge monopolies are viewed as necessary to internalize positive externalities—or spillovers—that flow from innovation." (footnotes omitted)).

164 Of course, information flow *can* be reciprocal if firms share labor pools and if inventors routinely move from one firm to another, taking important know-how to competitors. Still, in this case, one does not get a network effect, which happens when inventors that *stay* in a given firm collaborate on a joint project across boundaries with inventors who—because they are embedded in different business practices and routines—bring a different perspective to the problem at hand. *See, e.g.*, Pedraza-Fariña, *supra* note 3 (describing sociological research on boundary-crossing and innovation).

165 To be clear, the studies described in this Article suggest, but do not conclusively show, that social welfare would be enhanced if some types of informal information sharing were allowed to proceed unencumbered by manager opposition.

informal information-exchange networks.[166] By strong trade secret protection, I mean, for example, a broad scope of the type of information that is considered a trade secret; a high implicit duty of confidentiality that attaches to all employees; routine grants of injunctive relief or high damage awards; endorsement of the inevitable disclosure doctrine; and enforcement of the related doctrine of post-employment covenants not to compete.[167]

When trade secret protection is weak, managers have two options. First, they can choose to increase self-help measures to prevent employee disclosure. But the effectiveness of self-help measures such as enhanced security and information fragmentation is greatly diminished when employees are part of the same epistemic community in a local innovation cluster. In these communities, information has a tendency to leak out. In contrast to the effectiveness of legal sanctions (through trade secret and non-compete protection), which deter both employees from sharing information across boundaries *and* firms from hiring competing firms' employees (lest they be embroiled in trade secret litigation), maintaining secrecy through private means is likely to be a very costly and ultimately fruitless endeavor. Second, managers can choose to adapt to inventors' information-sharing social norms by developing a networked organizational structure. This appears to be what happened in several Silicon Valley firms where a hybrid public/private set of social norms that favored the open sharing of some forms of information across firms slowly emerged.[168]

Of course, in the absence of both transaction costs and asymmetric information between parties, whether trade secret law is aligned with managers' or inventor-employees' preferences will not matter. Managers and their employees will be able to bargain for their preferred arrangement. In other words, trade secret law acts as a default rule. But the real-world employment contexts described in this Article depart in one important way from this ideal, frictionless scenario. Firms and managers—as repeat players in negotiating employment contracts—are likely to possess superior information regarding the content of background trade secret laws that serve as default rules. If this is the case, setting default trade secret law to favor the preferences of employee-inventors rather than managers enhances efficiency by acting as what Ian Ayres and Robert Gertner have termed a "penalty default."[169]

166 *See, e.g.*, Fleming et al., *supra* note 77, at 521, 540 ("Willingness to share information appears to be more strongly correlated with a managerial versus technical profession than with location."); Oliver & Liebeskind, *supra* note 95; Waltz, *supra* note 118, at 880; Wright & Wallace, *supra* note 118.

167 *See* discussion *infra* Section III.A.

168 *See* SAXENIAN, *supra* note 77, at 35; Gilson, *supra* note 27, at 596 (describing how early in Silicon Valley's development "employers responded to departing employees by taking legal action," and how "[o]nly the failure of these efforts led to employer acceptance of high velocity employment.").

169 Ian Ayres & Robert Gertner, *Filling Gaps in Incomplete Contracts: An Economic Theory of Default Rules*, 99 YALE L.J. 87, 97 (1989). Penalty defaults give the most informed party to a transaction (here, firms) an incentive to contract around the default. In so doing, they

2. Fragmentation of Scientific and Technological Research and Underinvestment in Employee Training

The second predicted consequence of no (or weak) trade secret protection is the fragmentation of scientific knowledge due to selective revealing of trade secrets by firms to their inventors. In regions characterized by clustering and knowledge networks, however, the opposite was true. In fact, a hallmark of these regions is the fluid exchange and recombination of know-how among members of particular epistemic communities. There are two interconnected explanations for this. First, the strong pull of social norms of reciprocity and openness in epistemic communities of inventors, combined with inventors' shared interest in advancing a particular technology, pushes against fragmentation and likely overcomes coordination problems among inventors. Second, realizing that preventing information sharing and pooling by their own employees is both costly and fruitless, firms in these complex and fast-moving industries likely do not attempt a knowledge-fragmentation strategy. This is in contrast with firms in more stable and less complex industries, where knowledge fragmentation is a viable and often used self-help strategy. For example, Coca-Cola is well known in the industry for making sure that only two employees at a time are aware of the full Coca-Cola formula.[170]

Finally, employee-inventor learning happens at breakneck speed in knowledge networks. Such learning is facilitated—rather than hampered—by the formation of local networks of information sharing. Learning that takes place in networks is also qualitatively different from learning that happens within firm boundaries. Interaction in networks combines both diversity and trust—two key ingredients for breakthrough innovation.[171] Diversity arises from contrasting firm cultures and routines. Trust emerges from membership in the same epistemic community. In this context, it matters less whether firms themselves underinvest in training—although interview data

incentivize firms and managers to release specific information to employee-inventors about their preferences regarding technical know-how exchanges. By making these preferences explicit, a penalty default rule would put future employee-inventors on notice that the information sharing practices they may take for granted in their epistemic communities are no longer viable in this particular firm environment. *Id.*

170 *See* William Lee Adams, *Is This the Real Thing? Coca-Cola's Secret Formula 'Discovered'*, TIME (Feb. 15, 2011), http://newsfeed.time.com/2011/02/15/is-this-the-real-thing-coca-colas-secret-formula-discovered/.

171 *See, e.g.*, Mathijs de Vaan, David Stark & Balázs Vedres, *Game Changer: The Topology of Creativity*, 120 AM. J. SOC. 1144 (2015) (arguing that groups with diverse cultural elements but overlapping membership are creativity-enhancing); Pedraza-Fariña, *supra* note 3 (synthesizing network research on the effects of diversity and trust on creativity and innovative output); Balázs Vedres & David Stark, *Structural Folds: Generative Disruption in Overlapping Groups*, 115 AM. J. SOC. 1150, 1151 (2010) ("[E]ntrepreneurship in the business-group context is driven by the intersection of cohesive groups where actors have familiar access to diverse resources available for recombination.").

from biotechnology and IT clusters suggests that firms *do* continue investing in training.[172]

What are the implications of these findings for trade secret doctrine? In industries where weak trade secret protection would lead to the creation of innovation networks, the benefits of strong trade secrets evaporate and we are left only with its costs to information diffusion. As Robert Bone remarked, some types of innovation "might be better off in an environment where information is shared rather than kept secret."[173] Economic and network sociologists have now amassed a significant amount of data showing precisely what types of innovations would be better off when information is openly shared. They are those that combine (1) complex innovation (fast-paced and with widely distributed knowledge across firms); with (2) an epistemic community with social norms of reciprocal open-sharing and thick local ties (often anchored by a university).

One may question, however, the feasibility of tailoring trade secret protection to fit the needs of particular industries. The next Part explores two related avenues for doing this. It first sketches several doctrinal entry-points where courts can incorporate contextual considerations of the value of informal networks. It then considers the advantages of state variation versus federal homogenization. A full exploration of the doctrinal consequences of informal networks, including an in-depth analysis of the interplay between federal and state trade secret protection, is beyond the scope of this Article. The next Part, however, begins this conversation.

III. Implications for Trade Secret Law Doctrine

A. *State Trade Secret Law*

Until the passage of the Defend Trade Secrets Act (DTSA) in 2016,[174] which created a federal cause of action for trade secret misappropriation, trade secrets were largely a creature of state law. Because most states have adopted the Uniform Trade Secrets Act (UTSA),[175] the contours of trade secret doctrine are fairly homogeneous across states—although there remain important differences among states in key doctrines.[176] This Section focuses on four such doctrines where, I argue, state-by-state variation tailored to local industry characteristics is desirable. The four doctrines are: (1) scope of

172 *See, e.g.*, Fleming et al., *supra* note 77.

173 Robert G. Bone, *The (Still) Shaky Foundations of Trade Secret Law*, 92 Tex. L. Rev. 1803, 1814 (2014).

174 Pub. L. No. 114-153, 130 Stat. 376 (codified as amended in scattered sections of 18 U.S.C.).

175 As of May 2013, the UTSA has been enacted by forty-seven states, and by the District of Columbia, Puerto Rico, and the U.S. Virgin Islands. *See Legislative Fact Sheet - Trade Secrets Act*, Unif. Law Comm'n, http://www.uniformlaws.org/LegislativeFactSheet.aspx?title=Trade%20Secrets%20Act (last visited Jan. 21, 2017).

176 These differences are particularly salient when one compares the law on the books versus the law as applied. While trade secret law doctrine can look quite similar on the books, its application is much less homogeneous. *See infra* Section III.B.

information that qualifies as general skill and knowledge versus trade secret; (2) scope of an employee's implicit duty of loyalty; (3) covenants not to compete; and (4) the inevitable disclosure doctrine.

According to the UTSA, a trade secret may consist of:

information, including a formula, pattern, compilation, program, device, method, technique, or process, that: (i) derives independent economic value, actual or potential, from not being generally known to, and not being readily ascertainable by proper means by, other persons who can obtain economic value from its disclosure or use, and (ii) is the subject of efforts that are reasonable under the circumstances to maintain its secrecy.[177]

Crucially, however, not all secret information qualifies as a trade secret: an individual may use the "general skill and knowledge" acquired during his or her employment freely.[178] Therefore, determining the line between what constitutes a trade secret and what is part of an inventor's general skill and knowledge influences the scope of trade secret protection. This potential doctrinal lever could restrict the scope of trade secret protection in complex industries with background epistemic communities. I examine how we may narrow the scope of trade secret protection through this doctrinal lever below.

If a trade secret is "misappropriated," or obtained by "improper means," the trade secret holder may seek civil remedies including an injunction, compensatory damages, and, in cases of bad faith or willful and malicious misappropriation, "exemplary" damages and reasonable attorneys' fees.[179] "Improper means" are generally acts that give rise to separate causes of action under tort or criminal statutes, such as "theft, bribery, misrepresentation, breach or inducement of a breach of a duty to maintain secrecy, or espionage through electronic or other means."[180] Courts have read into the employer-employee relationship a broad *implied* duty of loyalty and confidence on the part of employees. Breach of such implicit duty of loyalty and confidence also constitutes trade secret misappropriation, even in the

177 UNIFORM TRADE SECRETS ACT WITH 1985 AMENDMENTS § 1(4) (Nat'l Conference of Comm'rs on Unif. State Laws 1985) [hereinafter UTSA].

178 *See, e.g.*, SI Handling Sys., Inc. v. Heisley, 753 F.2d 1244 (3d Cir. 1985) ("Under Pennsylvania law an employee's general knowledge, skill, and experience are not trade secrets. Thus in theory an employer generally may not inhibit the manner in which an employee uses his or her knowledge, skill, and experience—even if these were acquired during employment." (citation omitted)).

179 UTSA §§ 1(2)(i), 2–3.

180 *Id.* § 1(1). Improper means can encompass conduct that is otherwise lawful, although the vast majority of trade secret cases concern conduct that violates another tort or criminal statute. The canonical case *E.I. duPont deNemours & Co. v. Christopher*, 431 F.2d 1012 (5th Cir. 1970), held "improper means" could expand beyond conduct proscribed in tort or criminal statutes. In *E.I. duPont deNemours*, the court found the use of an airplane over an unfinished duPont plant to determine its layout to constitute improper means. *See id.* at 1015.

absence of an explicit agreement spelling out the contours of such duty.[181] The wide reach of the duty of loyalty and confidence, however, can have an important chilling effect on the type of inter-firm information-sharing activities described in Sections I.B and I.C. I examine the impact of the duty of loyalty and confidence on the formation of information-sharing networks below.

Firms are often especially concerned about trade secret misappropriation in the context of employee migration to competing firms or to form start-ups. To prevent information sharing by departing employees, firms will often require employees to sign covenants not to compete, i.e., agreements to refrain from employment that competes with the employer's business for a certain period of time.[182] The main justification for enforcing covenants not to compete is the protection of employer trade secrets. States vary widely on their policies regarding non-competes, with California having adopted strong policies against enforcing contractual restrictions on employee mobility and other states taking a contrary approach.[183]

One particular trade secret doctrine, the inevitable disclosure doctrine, has emerged as a strong bulwark against the potential disclosure of trade secrets by employees who go on to work for competing firms (or who start their own competing venture). In its strong form, the inevitable disclosure doctrine enjoins employees from working for competing firms if they would *inevitably* disclose trade secrets in the course of employment—obviating the need for proof of actual disclosure by the departing employee.[184] In fact, the inevitable disclosure doctrine "gives the former employer the benefit of a covenant not to compete without actually having entered into one."[185] Once again, states have taken diverse positions on inevitable disclosure: neither California nor Massachusetts recognize inevitable disclosure as a viable theory of liability, while Illinois' courts have been more receptive to the doctrine.[186]

Covenants not to compete and the inevitable disclosure doctrine can have a chilling effect on employee migration. Because employee migration is strongly associated with the formation of local information-sharing networks, these two doctrines can also have a negative impact on the formation of knowledge networks.[187] The next subsections briefly analyze these four doc-

181 *See, e.g.*, Peter C. Quittmeyer, *Trade Secrets and Confidential Information Under Georgia Law*, 19 GA. L. REV. 623, 665–66 (1985) (discussing the implied duty of confidentiality in Georgia); Sharon K. Sandeen, *Relative Privacy: What Privacy Advocates Can Learn from Trade Secret Law*, 2006 MICH. ST. L. REV. 667, 699; Lars S. Smith, *Trade Secrets in Commercial Transactions and Bankruptcy*, 40 IDEA 549, 552 (2000).

182 *See Covenant Not To Compete*, BLACK'S LAW DICTIONARY (10th ed. 2014).

183 *See infra* Section III.B. In all states, however, covenants not to compete must be "reasonable" in order to be enforceable. *See, e.g.*, Barnett & Sichelman, *supra* note 114.

184 *See, e.g.*, Elizabeth A. Rowe, *When Trade Secrets Become Shackles: Fairness and the Inevitable Disclosure Doctrine*, 7 TUL. J. TECH. & INTELL. PROP. 167 (2005).

185 *See* Fisk, *supra* note 27, at 507.

186 *See* James A. Johnson, *Keeping Your Secrets Secret*, 87 N.Y. ST. B.J. 24, 25–26 (2015).

187 *See, e.g.*, Lobel, *supra* note 27, at 825–35.

trines and their influence on the formation of knowledge networks and propose modifications that take into account the characteristics of industries where knowledge networks are innovation-enhancing.

1. General Skill and Knowledge vs. Trade Secret Information

A fundamental set of countervailing public policies guides state law in establishing the dividing line between general skill and knowledge and trade secrets: the protection of business interests from unfair competition, on the one hand, and the public interest in labor mobility leading to "competition and the dissemination of ideas, which in turn benefit the consumer" on the other.[188]

Courts have recognized that the scope of what constitutes background skills and knowledge may be broader in high-technology industries. For example, the Third Circuit has noted that in "newer, high-technology industries," the attributes of the employee "are inextricably related to the information or process that constitutes an employer's competitive advantage."[189] In these cases, the court argues, "the legal questions confronting the court necessarily become bound up with competing public policies."[190] Such public policy considerations include allocating "resources of skill and information . . . in such a manner that they are utilized most efficiently to produce goods and services."[191] This public policy of efficient resource and information allocation provides a justification for narrowing the type of information that is considered a trade secret in complex fields with a background epistemic community. More specifically, it provides a justification for considering the type of technical know-how that is routinely informally exchanged in these industries (negative know-how, i.e., details about what does not work to solve a problem, and know-how regarding details about public experimental protocols) a part of an employee's general background knowledge.[192]

In fact, it appears that some states have taken the view that negative know-how constitutes general skill and knowledge (and falls outside trade secret protection), albeit not explicitly. For example, in *EarthWeb, Inc. v. Schlack*, the court found that under New York law an employee's "awareness

188 SI Handling Sys., Inc. v. Heisley, 753 F.2d 1244, 1268 (3d Cir. 1985).

189 *Id.* at 1267.

190 *Id.*

191 *Id.* at 1268.

192 *See* Tempo Instrument, Inc. v. Logitek, Inc., 229 F. Supp. 1, 3 (E.D.N.Y. 1964) ("The court is of the opinion that this know-how, alleged to have been disclosed to the defendant Fischer in a confidential relationship and then wrongly utilized by him, constitutes nothing more than the general knowledge and experience gained by an employee in any business and is, therefore, not actionable."); Robert Denicola, *The Restatements, the Uniform Act and the Status of American Trade Secret Law*, *in* THE LAW AND THEORY OF TRADE SECRECY: A HANDBOOK OF CONTEMPORARY RESEARCH, *supra* note 5, at 18, 25 (tracing the history of the Uniform Trade Secrets Act and explaining how it expanded the definition of trade secrets to include "negative" information—"knowledge that certain processes or methods will not work.").

of the trial and error process that [his employer] undertook in implementing the products and services of outside consultants" did not "rise to the status of a trade secret."[193] Significantly, the court found unpersuasive the employer EarthWeb's arguments that its former employee's awareness of such trial and error process would impermissibly allow him to "avoid the mistakes that EarthWeb made in the past" when solving similar problems for a competitor.[194] Awareness of trial and error processes is simply an awareness of what doesn't work, i.e., negative know-how as defined in this Article.

2. Duty of Loyalty and Duty of Confidence

Trade secret doctrine "accepts as given that employment is a relationship of 'trust and confidence' that obligates the employee to keep some information secret," even in the absence of an explicit contractual agreement to do so.[195] But this broad interpretation of the implicit duties inherent in any employer-employee relationship is not in alignment with the practices and understandings of high-technology inventors in the innovation clusters surveyed in this Article. Indeed, biotechnology companies seem to recognize this gap—several articles in biotechnology publications feature attorneys dispensing advice to companies on how to rid their employees of their open-sharing ethos.[196] Courts' understanding of such a broad implicit duty of confidentiality constitutes a strong trade secret norm.[197] For the reasons outlined in subsection I.B.1 these background rules of strict confidentiality that discourage interaction across firm boundaries, however, are likely to have a chilling effect on the socially beneficial practices of open-sharing described in Part I.

Why have courts adopted such an understanding of the background duties of employees towards their employers? As Catherine Fisk shows in her historical study of the emergence of trade secret law, this implicit duty of loyalty and confidence is a relatively new doctrinal development.[198] Furthermore, this development is not grounded in careful policy analysis regarding what background rule most efficiently promotes innovation, or other societal goals or values. Rather, it emerged gradually from the expansion to all

193 EarthWeb, Inc. v. Schlack, 71 F. Supp. 2d 299, 305, 315 (S.D.N.Y. 1999).

194 *Id.* at 305.

195 Fisk, *supra* note 27, at 452.

196 *See, e.g.*, Elliott, *supra* note 118, at 293 ("Often informal, biotech companies tend to draw employees from academia, where advancement and reputation are built on publication, not secrecy. Such employees must be schooled to avoid disclosure at trade conferences or in presentations or papers, and to understand that the innovations they work on are their employer's property, to publicize or withhold as it sees fit." (footnote omitted)); Waltz, *supra* note 118; Wright & Wallace, *supra* note 118.

197 *See, e.g.*, Fisk, *supra* note 27 (showing the gradual expansion of the implicit duty of loyalty in employee-employer relationships).

198 *See id.* at 452–53 ("In 1800, trade secret doctrine as such did not exist. Only some employment relations were characterized as confidential and, therefore, incorporated an obligation not to divulge workplace secrets. . . . Skilled workers would have been bound by none of these obligations.").

employment relationships of two bodies of law—master-servant and agency—that were originally narrowly applied to a subset of work relationships.[199] Until the early 1900s, outside of master-servant and agency relationships, the basis for confidentiality was grounded in express contracts.[200] And the scope of the information protected by trade secrets remained relatively narrow—confined to tangible things such as drawings (and certainly excluding negative knowledge).[201]

This transition from relying on express contracts to set out the extent of employees' duties to reading an implied duty of confidence and loyalty into all employment relationships reflected a conceptual shift in how courts interpreted workplace knowledge.[202] Such knowledge increasingly came to be seen as the property of firms, rather than the background skill and technical knowledge of individual inventors, which they could freely exchange and disclose.[203] But when important knowledge is generated in informal collaboration networks that cross firm boundaries, this strong norm that treats an ever expanding amount of knowledge as originating within and belonging to individual firms can be counter-productive for overall innovation. It is also out of tune with innovation-enhancing practices of research clusters.

Two important corrections to how courts interpret employees' duties of confidentiality and loyalty can help better align legal rules and innovation incentives, and complement my earlier proposal to expand what constitutes "general skill and knowledge" in these industries. First, in both master-servant law and agency, the policy reason underlying the duty of loyalty and confidence is to prevent opportunistic behavior.[204] When there is reciprocal exchange across firms through epistemic networks, there is no such opportunistic behavior. Rather, innovation in networks involves a process of collective learning that benefits the entire innovation cluster. Second, two crucial elements of know-how that are often *only* exchanged (and available) informally are (1) negative know-how—information about what *does not work* to

199 *See id.* at 450–53.

200 *See id.* at 492 (emphasizing that the duty to keep secrets "was grounded in express contract or in a traditionally confidential relationship like that of attorney and client; it did not arise simply from the fact of employment").

201 *See id.* at 492–93.

202 *See id.* at 498–503.

203 *See* Cincinnati Bell Foundry Co. v. Dodds, 10 Ohio Dec. Reprint 154, 158 (Super. Ct. 1887) ("I am inclined to think that his obligation to preserve such secret as the property of his employer must be implied, even though nothing was said to him on the subject."); *see also* Fisk, *supra* note 27, at 504 ("What changed over the century was not the judicial ability to imagine the economic value of all the knowledge and experience of a skilled workman or plant superintendent but the judicial ability to imagine such knowledge as the exclusive property of a firm.").

204 *See* Horace Gay Wood, A Treatise on the Law of Master and Servant 225 (2d ed. 1886) (discussing an implied duty of confidentiality that prevents an employee from making "any attempt on his part to use the secret for his own interests against the master").

solve a particular problem[205]—and (2) details regarding how to get publicly available protocols to work.[206]

These findings dictate an important correction to courts' current interpretations of employees' implicit duties regarding the exchange of technological know-how. In the absence of an express contract governing employment relationships, courts should take a contextual, case-by-case view of employee duties—rather than imply a blanket duty of confidentiality to all employer-employee relationships. In particular, in defining whether there is an implied duty of loyalty and confidence and in ascertaining its scope, courts should take into account the background norms in specific industries, in particular whether particular informational exchanges are reciprocal, occur in innovation clusters, and occur through an epistemic network that cuts across firm boundaries. If these three conditions are met, the implied duty of loyalty and confidence should be interpreted very narrowly to apply only to non-reciprocal acts of opportunistic behavior on the part of employees, and to exclude reciprocal exchanges of negative know-how and knowledge about how to perform publicly available protocols.

Tailoring the implied contract rule to the actual information-exchange practices in particular innovation communities may push employers to sign

205 *See, e.g.*, Natalie Matosin et al., *Negativity Towards Negative Results: A Discussion of the Disconnect Between Scientific Worth and Scientific Culture*, 7 DISEASE MODELS & MECHANISMS 171 (2014) (discussing the difficulties in communicating negative results through printed media); Jonathan Schooler, *Unpublished Results Hide the Decline Effect*, NATURE (2011), http://www.nature.com/news/2011/110223/full/470437a.html.

206 Experimental protocols are generally publicly available either through publication in the "Materials and Methods" section of scientific or trade journals, or by publication in a patent specification or disclosure. It is exceedingly common, however, for researchers to be unable to replicate an experimental protocol simply by looking at the published set of instructions. Informal exchanges among researchers are the most common way to address this problem. *See, e.g.*, Jocelyn Kaiser, *The Cancer Test*, SCI., June 26, 2015, at 1411, 1413 ("Amassing all the information needed to replicate an experiment . . . proved more complex and time-consuming than we ever imagined [because] . . . [p]rincipal investigators had to dig up notebooks and raw data files and track down long-gone postdocs and graduate students." (quoting a leading scientist on his efforts to replicate experiments in cancer biology)); Brian A. Nosek & Timothy M. Errington, *Reproducibility in Cancer Biology: Making Sense of Replication*, ELIFE (Jan. 19, 2017), https://elifesciences.org/content/6/e23383. The efforts described in these two publications are part of the Reproducibility Initiative—which seeks to replicate results in prominent cancer biology papers. The Reproducibility Initiative got its start after publications by two pharmaceutical companies, Amgen and Bayer, claimed that only eleven and twenty-one percent, respectively, of prominent cancer biology studies could be replicated. Unsurprisingly in the context of this article, the two study authors who worked at Amgen and Bayer could not divulge which particular studies they had been unable to replicate: they had signed confidentiality agreements with these two pharmaceutical companies that prevented them from divulging this "negative know-how." Kaiser, *supra*, at 1412; *see also* C. Glenn Begley & Lee M. Ellis, *Drug Development: Raise Standards for Preclinical Cancer Research*, 483 NATURE 531 (2012) (reporting the results of the Amgen studies); Florian Prinz et al., *Believe It or Not: How Much Can We Rely on Published Data on Potential Drug Targets?*, 10 NATURE REV. 712 (2011) (reporting the results of the Bayer studies).

express contracts with their employees outlining their expectations regarding information exchange.[207] If managers' expectations differ widely from those of the innovator communities—as was the case in the innovation clusters surveyed here—this will prompt a confrontation between background open-sharing norms and express expectations of secrecy. It will also, as predicted in theoretical models of trade secrets outlined in Part II, increase managers' efforts to control information exchange through other self-help measures. The outcome of such confrontation depends in large part on the strength of the background norms of the epistemic inventor community.[208]

3. Inevitable Disclosure Doctrine and Covenants not to Compete

In this Article, I have emphasized the importance of networks of *inter*-industry information exchange in advancing innovation in complex industries. Previous research on trade secrets and related doctrines, such as covenants not to compete and non-solicitation agreements, has focused largely on the role and importance of employee migration to competing firms for overall innovation.[209] This focus has been driven by the conclusion that information dissemination in successful industrial clusters takes place largely through employee migration.[210] In this model, employee migration generates important knowledge spillovers as employees transfer ideas and crucial know-how to other local firms.

Although employee migration to competing firms is undoubtedly important for innovation in clusters, this Article emphasizes an equally important, yet underexplored, source of information diffusion in technology clusters: reciprocal information exchange across firm boundaries through networks of employees who collaborate while employed at competing firms.[211] In fact, many of the collaborations that are hailed as having fueled Silicon Valley's early success are inter-firm collaborations between IBM and several other Silicon Valley firms.[212]

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207 *See, e.g.*, Harley & Lund Corp. v. Murray Rubber Co., 31 F.2d 932, 934 (2d Cir. 1929) ("[T]ime creates no prescriptive right in other men's labor. If an employer expects so much, he must secure it by contract.").

208 Apple's recent decision to allow its artificial intelligence and machine learning people to publish some of their results is an example of how the clash between managers' and inventors' background social norms and interests regarding disclosure may lead to a change in company policy. John Gruber, *Apple's AI Team Publishes First Research Paper*, DARING FIREBALL (Dec. 26, 2016), http://daringfireball.net/linked/2016/12/26/apple-ai-research-paper.

209 *See, e.g.*, LOBEL, *supra* note 27, at 49–57; Catherine Fisk, *Taking the Long View on Competition and the Mobile Employee: Lessons from the United States History of Efforts to Regulate Employee Innovation and the Mobility of Workplace Knowledge*, *in* BUSINESS INNOVATION AND THE LAW: PERSPECTIVES FROM INTELLECTUAL PROPERTY, LABOUR, COMPETITION AND CORPORATE LAW 214 (Marilyn Pittard et al. eds., 2013) [hereinafter Fisk, *Taking the Long View*]; Fisk, *supra* note 27; Fisk & Barry, *supra* note 27; Gilson, *supra* note 27; Lobel, *supra* note 27.

210 *See supra* note 22.

211 *See supra* Sections I.B, I.C.

212 *See supra* Sections I.B, I.C.

Moreover, the reasons *why* employee migration can be innovation-enhancing also remain underdeveloped. Employees are not simply vessels for the flow of know-how, although this is certainly one of the functions of employee mobility. Rather, employee migration is also important because it enables the creation of bonds of trust across firms, which subsequently enable informal information exchanges.[213] Employees who previously worked together for a single firm can develop the necessary level of trust to continue collaborating across firm boundaries when they migrate to competing firms. This dynamic is in fact what facilitated collaboration in the Silicon Valley cluster.[214] Both the Silicon Valley and Boston clusters saw a high amount of collaboration—driven by belonging to the same epistemic community of researchers trained by universities.[215] But Silicon Valley experienced a much higher amount of inter-firm collaboration than Boston because of a single institutional post-doctoral program hosted by IBM.[216] That program trained post-doctoral fellows who went on to work for other firms but stayed in touch with each other. In other words, the post-doctoral program created links of trust among its participants that carried over to employment in other firms. Indeed, many of the collaborations that are hailed as having fueled Silicon Valley's success are inter-industry collaborations that sprang from IBM's postdoctoral program.[217] At the time, IBM held an unusual managerial attitude towards employee migration: viewing the IBM postdoctoral program as a tool to spread the "IBM way" across a variety of firms.[218] The same is true of the San Diego cluster. Employees from the failed diagnostics company Hybritech stayed in the San Diego area and went on to found start-ups that routinely exchanged information and collaborated with each other—in large part because of having previously worked together at Hybritech.[219]

How should this second role of employee migration—enhancing the local reservoir of trust across firms in innovation clusters—inform courts' treatment of the inevitable disclosure doctrine and the enforceability of covenants not to compete? In essence, appreciating the importance of migration for trust-building uncovers an additional benefit to the free circulation of human capital.

First, the inevitable disclosure doctrine can chill local employee migration. It is, in the language used in Part II, a strong trade secret protection

213 *See supra* Section I.B, I.C; *see also* Fleming et al., *supra* note 77, at 537 ("IBM assumed that [members of its post-doctoral program] would depart as ambassadors for the firm.").

214 Fleming et al., *supra* note 77; Fleming & Frenken, *supra* note 8.

215 Fleming et al., *supra* note 77; Fleming & Frenken, *supra* note 8.

216 Fleming et al., *supra* note 77, at 539 ("Silicon Valley aggregated before Boston because Stanford graduates took employment at IBM's Almaden Valley Labs and because IBM sponsored a postdoctoral program that seeded the Valley with IBM patent coauthors.").

217 *Id.*

218 *Id.*

219 Powell, Packalen & Whittington, *supra* note 8, at 449; *see also* GLOBAL CONNECT, BIOTECHNOLOGY CLUSTER PROJECT: SAN DIEGO ANALYSIS 13–15 (2010).

norm that is out of sync with the background social norms of innovators in the innovation clusters described in Section I.C. By enjoining employees from using know-how acquired during their employment in competing firms because, as one court put it, employees, even those acting in good faith, will inevitably rely on information "held in [their] head[s]," the inevitable disclosure doctrine acts as a judicially created covenant not to compete, but without the safeguards of a negotiated, contractual arrangement between an employer and an employee.[220] Courts that apply the inevitable disclosure doctrine have, for example, banned employees from starting employment with a new employer for several months, and for working on particular projects for years—despite lacking evidence of actual misappropriation.[221]

There is, however, wide variation in how states that recognize the inevitable disclosure doctrine apply it to particular cases.[222] One important variation for the purpose of this Article concerns the importance of a finding of "bad faith" on the part of a departing employee. For example, in the leading "inevitable disclosure" case, *PepsiCo, Inc. v. Redmond*,[223] the Seventh Circuit, applying Illinois state law, enjoined a PepsiCo employee from "assuming any duties with Quaker relating to beverage pricing, marketing, and distribution,"[224] based in part on the employee's "lack of forthrightness on some occasions, and out and out lies on others" to his colleagues at PepsiCo.[225] The court in *PepsiCo* emphasized the importance of a showing of "bad faith" to make an inevitable disclosure claim. Under *PepsiCo*, a departing employee's bad faith serves as key evidence of his or her intent to reveal trade secrets in his or her new employment. Yet, other courts have issued injunctions under an inevitable disclosure theory even upon finding that the former employee had acted in good faith. For example, in *Merck & Co. v. Lyon*,[226] the court explained: "when . . . the possibility of disclosure [is] high and the value to the competitor great, an injunction would issue even when there had been no bad faith or underhanded dealing by the former employee or the competitor."[227]

To foster the emergence of knowledge networks, the inevitable disclosure doctrine should be narrowed in two ways. First, it should be limited to cases in which opportunistic behavior or "bad faith" on the part of employees can be documented. In cases of opportunistic behavior, where the employee secretly absconds with work done by others at the employing firm, it is exceedingly unlikely that employee migration will generate the kind of reser-

220 Barilla Am., Inc. v. Wright, No. 4-02-CV-90267, 2002 WL 31165069, at *9–10 (S.D. Iowa July 5, 2002).

221 *See* Rowe, *supra* note 184.

222 *Id.* (summarizing state variation in the application of the inevitable disclosure doctrine).

223 54 F.3d 1262 (7th Cir. 1995).

224 *Id.* at 1263.

225 *Id.* at 1270 (quoting PepsiCo, Inc. v. Redmond, No. 94 C 6838, 1996 WL 3965, at *33 (N.D. Ill. Jan. 2, 1996)) (internal quotation marks omitted).

226 941 F. Supp. 1443 (M.D.N.C. 1996).

227 *Id.* at 1460.

voir of trust that leads to the formation of inter-firm networks. In other words, "bad faith" is not only an indicator of the likelihood a former employee would reveal trade secrets in his or her new job, but also an indicator that a particular employee migration would not be trust-enhancing. In contrast, when "bad faith" is absent, the inevitable disclosure doctrine chills employee mobility when it would be most profitable for network formation, i.e., when it would create a reservoir of trust among employees across firms that would facilitate reciprocal information exchange.

Second, the inevitable disclosure doctrine is particularly pernicious to cluster formation when it prevents employees from revealing, and using, negative technical know-how and troubleshooting insights for experimental protocols that they have acquired through their previous employment. Technical know-how and troubleshooting insights for experimental protocols are two pieces of information that are shared often across epistemic networks of scientists.[228] Advances in complicated technological frontiers are simplified enormously if all involved share information on false starts and blind alleys, and on specific "tricks" for getting a public protocol to work, so that experimental failures need not be repeated. And because negative know-how and technical troubleshooting insights are almost never distributed in printed format, word-of-mouth diffusion is the only way to hear about these false starts (other than having to make those mistakes oneself).[229] In addition, as others have argued, depriving innovators of their ability to change jobs simply because they may "subconsciously" reveal negative know-how acquired through previous employment, or worse, forcing them to repeat errors in new employment—lest they rely on trade secret negative knowledge—is impractical, likely inefficient for overall innovation, and injurious to employee motivation.[230] The inefficiencies associated with applying the inevitable disclosure doctrine to negative know-how are magnified in industries where clusters are found to be beneficial: high-technology, fast moving, complex industries with a background epistemic network motivated to advance a particular technological frontier.

Finally, changing trade secret law's background assumptions regarding the scope of an employee's general background knowledge and skills, employer-employee duty of loyalty and confidence, and the inevitable disclosure doctrine, curtail the reach of trade secrets, but still leave contracts as a viable, alternative option for employers. As I argued in Part II, a penalty default trade secret regime that forces firms to contract around and reveal their information-sharing preferences to future employees is likely efficiency-enhancing. Indeed, covenants not to compete are a contractual strategy that can increase the reach of trade secret law by providing restrictions on an employee's choices for future employment. In most states, courts will enforce covenants not to compete, so long as they are "reasonable," i.e., lim-

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228 *See, e.g.*, BIOFORUM, http://www.protocol-online.org/forums/ (last visited Jan. 19, 2017).

229 *See, e.g.*, Schooler, *supra* note 205.

230 *See, e.g.*, Gilson, *supra* note 27, at 624; Lobel, *supra* note 27, at 839–42.

ited in time, place, and scope.[231] California is the exception to this rule. Pursuant to California Business and Professions Code section 16600, "every contract by which anyone is restrained from engaging in a lawful profession, trade, or business of any kind is to that extent void."[232] California will, however, enforce covenants not to compete that are narrowly tailored to protect only the disclosure of trade secrets.[233]

The analysis developed in Part II can provide guidelines for interpreting what constitutes a "reasonable" restriction on competition, and for identifying circumstances in which covenants not to compete should be presumed unenforceable. First, in high-technology industries, where innovation is fast-moving and there is an underlying epistemic community (often tethered to a university) that favors open communication, there is a strong argument for a presumption against covenants not to compete that go beyond the narrow tailoring adopted in California. Second, reasonableness should be interpreted in light of background innovation-enhancing social norms of innovators in these clusters. This means that, even those covenants that are narrowly tailored to protect trade secrets should not encompass negative know-how and knowledge about how to successfully perform publicly available protocols—the type of information that is most often reciprocally shared among innovation clusters. Of course, courts could reach the same conclusion simply by narrowing the scope of what constitutes a trade secret in the first place, as I argue in subsection III.A.1.

B. State Experimentalism vs. Federal Uniformity

This final section is necessarily brief. It is not intended to be a comprehensive exploration of the tension between state and federal jurisdiction in trade secret law. Rather, it is meant to set the stage to begin exploring how the importance of local, informal informational exchanges in complex industries may inform the balance between state and federal trade secret law.

State trade secret law remains heterogeneous, despite most states having adopted the Uniform Trade Secrets Act (UTSA).[234] Specifically, states have taken different approaches to the doctrines I have engaged with above: the types of information that qualify as a trade secret, the scope of employees' duty of loyalty, the viability of inevitable disclosure theories, and the enforceability of covenants not to compete.

For example, in New York (one of the few states that has not adopted the UTSA) technical negative know-how arguably does not qualify as a trade secret but constitutes part of an employee's background "technical knowl-

231 *See* Barnett & Sichelman, *supra* note 114.

232 CAL. BUS. & PROF. CODE § 16600 (West 2016).

233 Jeffrey S. Klein et al., *The Trade Secrets Exception to California's Ban on Employee Noncompetition and Nonsolicitation Agreements After* Edwards v. Arthur Andersen, LLP, WEIL (Dec. 6, 2013), http://www.weil.com/articles/the-trade-secrets-exception-to-californias-ban-on-employee-noncompetition2_12-06-2013.

234 *See* David S. Almeling, *Four Reasons to Enact a Federal Trade Secrets Act*, 19 FORDHAM INTELL. PROP., MEDIA & ENT. L.J. 769, 772–75 (2009).

edge."[235] In contrast, California appears to protect negative information as trade secrets.[236] And Utah has been explicit in its choice to protect both positive and negative technical information.[237] The scope of an employee's duty of loyalty also varies by jurisdiction.[238] Recent decisions in California have construed the duty narrowly, emphasizing that a broad duty of loyalty would ignore the "consistent safeguards upon employee mobility and the freedom to work in the state of California."[239] Similarly, in Massachusetts the duty of loyalty applies only to some (high-ranking) employees.[240] In contrast, New York recognizes a stronger common law duty of loyalty for all employees at all times prior to termination of employment.[241] The applicability of the inevitable disclosure doctrine also varies by state. California has refused to recognize the doctrine as inimical to state public policy in favor of employee mobility.[242] Colorado[243] and Maryland[244] have taken the same approach. Other states, such as Illinois, Connecticut, and Delaware, however, have applied the doctrine on multiple occasions.[245] Finally, a handful of states (California, Colorado, Hawaii, Montana, North Dakota, and Oklahoma) have held covenants not to compete generally unenforceable, even if reasonable in purpose and scope, with some specific exceptions.[246]

Commentators have generally viewed these discrepancies with suspicion and argued for greater uniformity in trade secret law.[247] State variation is

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235 *See, e.g.*, EarthWeb, Inc. v. Schlack, 71 F. Supp. 2d 299, 305, 315 (S.D.N.Y. 1999); *see also* discussion *supra* subsection III.A.1.

236 *See* Cinebase Software, Inc. v. Media Guar. Tr., Inc., No. C98-1100, 1998 WL 661465, at *12 (N.D. Cal. Sept. 22, 1998) ("'Negative research' can be protectable as a trade secret.").

237 *See, e.g.*, Novell, Inc. v. Timpanogos Research Grp., Inc., 46 U.S.P.Q.2d 1197, 1216–17 (Utah Dist. Ct. 1998).

238 *See, e.g.*, Mattel, Inc. v. MGA Entm't, Inc., No. CV 04-9049, 2011 WL 8427611 (C.D. Cal. Mar. 28, 2011).

239 *Id.* at *2.

240 *See, e.g.*, Robinson v. Watts Detective Agency, Inc., 685 F.2d 729, 736 (1st Cir. 1982); Sterling Research, Inc. v. Pietrobono, No. 02-40150, 2005 WL 3116758, at *10 (D. Mass. Nov. 21, 2005); Meehan v. Shaughnessy, 535 N.E.2d 1255 (Mass. 1989) (partners).

241 *See, e.g.*, Am. Fed. Grp., Ltd. v. Rothenberg, 136 F.3d 897, 905 (2d Cir. 1998).

242 Bayer Corp. v. Roche Molecular Sys., Inc., 72 F. Supp. 2d 1111, 1119–20 (N.D. Cal. 1999).

243 Saturn Sys., Inc. v. Militare, 252 P.3d 516, 526 (Colo. App. 2011).

244 LeJeune v. Coin Acceptors, Inc., 849 A.2d 451, 471 (Md. 2004).

245 *See, e.g.*, CTRE, LLC v. Colburn, No. CV074028031, 2008 WL 2796870, at *8 (Conn. Super. Ct. June 20, 2008); W.L. Gore & Assocs. v. Wu, No. Civ.A. 263-N, 2006 WL 2692584, at *17 (Del. Ch. 2006); Strata Mktg., Inc. v. Murphy, 740 N.E.2d 1166, 1178 (Ill. App. Ct. 2000).

246 CAL. BUS. & PROF. CODE §§ 16600-16602.5 (West 2016); COLO. REV. STAT. § 8-2-113 (2016); HAW. REV. STAT. § 480-4 (2016); MONT. CODE ANN. §§ 28-2-703 to -705 (2016); N.D. CENT. CODE § 9-08-06 (2016); OKLA. STAT. tit. 15, §§ 217-219a (2016).

247 *See* Marina Lao, *Federalizing Trade Secrets Law in an Information Economy*, 59 OHIO ST. L.J. 1633(1998); James Pooley, *The Myth of the Trade Secret Troll: Why the Defend Trade Secrets Act Improves the Protection of Commercial Information*, 23 GEO. MASON L. REV. 1045, 1047 (2016) ("[F]ederalizing civil trade secret law fills a critical gap in effective enforcement of

thought to dampen innovation by creating uncertainty regarding applicable state law, leading to "increased inefficiency and costs associated with investigating and complying with different states' requirements [for achieving trade secret protection], and ultimately less investment in innovation."[248] More recently, however, and in the wake of congressional initiatives to create a federal cause of action for trade secret protection, academic commentators have often opposed the federalization of trade secret law on a variety of grounds.[249]

The Defend Trade Secrets Act (DTSA) is the culmination of several congressional initiatives to federalize (and thus harmonize) state trade secret law.[250] The DTSA enacts a private, federal cause of action for trade secret misappropriation, based on congressional power under the Commerce Clause.[251] The DTSA does not preempt state trade secret law;[252] nevertheless, and depending on the interpretation of key DTSA provisions, it will have a direct impact on the ability of states to experiment effectively with different levels of local trade secret protection.[253] First, although the DTSA adopts a

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private rights against cross-border misappropriation that has become too stealthy and quick to be dealt with predictably in state courts. The DTSA accomplishes this by effecting only very modest changes, relying heavily on existing laws and rules."); Alissa Cardillo, Note, *Another Bite at the Apple for Trade Secret Protection: Why Stronger Federal Laws Are Needed to Protect a Corporation's Most Valuable Property*, 10 BROOK. J. CORP. FIN. & COM. L. 577, 603 (2016) (arguing that the federal courts provide a superior forum for trade secret litigation because they are "better suited to deal with diverse parties from different states or countries").

248 Rebecca Filipovic, *Will Trade Secrecy Finally Join Its IP Siblings, Patents Trademarks and Copyright, in Federal Court?*, MCKEON, SHELDON, MEHLING, LLC (Feb. 10, 2015), http://msmhawaii.com/2015/02/will-trade-secrecy-finally-join-its-ip-siblings-patents-trademarks-and-copyright-in-federal-court/.

249 *See, e.g.*, Stephen Anderson, *The Defend Trade Secret Act: Arrival of the Trade Secret Trolls?*, 2015 B.C. INTELL. PROP. & TECH. F. 1; Stephen Y. Chow, *DTSA: A Federal Tort of Unfair Competition in Aerial Reconnaissance, Broken Deals, and Employment*, 72 WASH. & LEE L. REV. ONLINE 341, 344 (2016); Eric Goldman, *Ex Parte Seizures and the Defend Trade Secrets Act*, 72 WASH. & LEE L. REV. ONLINE 284 (2015); David S. Levine & Sharon K. Sandeen, *Here Come the Trade Secret Trolls*, 71 WASH. & LEE L. REV. ONLINE 230 (2015); Sharon K. Sandeen, *The DTSA: The Litigator's Full Employment Act*, 72 WASH. & LEE L. REV. ONLINE 308 (2015); Christopher B. Seaman, *The Case Against Federalizing Trade Secrecy*, 101 VA. L. REV. 317 (2015); Professors' Letter in Opposition to the Defend Trade Secrets Act of 2015 (Nov. 17, 2015), https://cyberlaw.stanford.edu/files/blogs/2015%20Professors%20Letter%20in%20Opposition%20to%20DTSA%20FINAL.pdf [hereinafter Letter].

250 *See* Defend Trade Secrets Act of 2016, Pub. L. No. 114-153, 130 Stat. 376 (codified as amended in scattered sections of 18 U.S.C.).

251 "An owner of a trade secret that is misappropriated may bring a civil action under this subsection if the trade secret is related to a product or service used in, or intended for use in, interstate or foreign commerce." 18 U.S.C.A. § 1836(b)(1) (West 2016).

252 "Except as provided in section 1833(b), this chapter shall not be construed to preempt or displace any other remedies . . . provided by . . . State . . . law for the misappropriation of a trade secret." 18 U.S.C.A. § 1838.

253 *See, e.g.*, Levine & Sandeen, *supra* note 249 (arguing that the DTSA is overly skewed towards trade secret holders, betraying a conception of trade secrets as strong "property"

definition of trade secret that is largely co-extensive with the UTSA, significant interpretive ambiguities remain.[254] It is unclear, for example, whether the DTSA allows the protection of negative know-how,[255] and what types of information fall under the rubric of trade secrets.[256] The availability of an alternative cause of action with a broader scope of protection than that available in some states (for example, protection for negative technical know-how) will necessarily ratchet up overall trade secret protection in any state, making it all but impossible for any individual state to effectively set a lower scope of protection. Second, it is unclear how courts will interpret the scope of an employee's duty of loyalty under the DTSA, since this term is not explicitly defined in the statute. As Sharon Sandeen and Christopher Seaman argue, "without any statutory definition or associated commentary (as exists in the case of the UTSA), it is unclear whether federal courts can (and should) interpret those terms anew or apply the meaning of those terms as developed under state law."[257] A new, federal interpretation of the scope of

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rights but failing to appreciate the equal importance of employee mobility and information diffusion for sound trade secret law and policy); Sandeen, *supra* note 249, at 313, 319–20 (arguing that the DTSA will result in "a large percentage of all cases currently filed in state courts [being] filed in federal courts," and in "attorneys for both plaintiffs and defendants . . . argu[ing] for the creation of federal trade secret principles over established state law principles when it suits their client's interests"); Seaman, *supra* note 249, at 365–68 (arguing that federalizing trade secret law will prevent states from experimenting with "what amount of legal protection is most likely to foster innovation and promote economic growth"). *But see* Pooley, *supra* note 247, at 1047 ("Having no preemptive effect, the federal law leaves in place all relevant state laws and policies, allowing federal courts to address issues of concurrent jurisdiction as they have in other areas of the law.").

254 *See, e.g.*, Sharon K. Sandeen & Christopher B. Seaman, *Toward a Federal Jurisprudence of Trade Secret Law* (2017) (on file with author) (making this argument). Additionally, two key states for the complex industries described in this Article, Massachusetts and New York, have not adopted the UTSA.

255 There is a persuasive argument that the DTSA does not protect negative know-how, because this type of information is not "related to" a product or service, as required under the Commerce Clause. From the perspective of knowledge networks advanced in this Article, this interpretation is innovation-enhancing, as it would allow tailoring by leaving the decision of whether to protect negative know-how to individual states. *See* 18 U.S.C.A. § 1836 (b)(1) ("An owner of a trade secret that is misappropriated may bring a civil action under this subsection if the trade secret is related to a product or service used in, or intended for use in, interstate or foreign commerce."); *see also* Sandeen & Seaman, supra note 254.

256 *See, e.g.*, Sandeen & Seaman, *supra* note 254. *Compare* 18 U.S.C.A. § 1839(3) (DTSA's definition of "trade secret," one that includes "all forms and types of financial, business, scientific, technical, economic, or engineering information, including patterns, plans, compilations, program devices, formulas, designs, prototypes, methods, techniques, processes, procedures, programs, or codes, whether tangible or intangible, and whether or how stored, compiled, or memorialized physically, electronically, graphically, photographically, or in writing"), *with* CAL. CIV. § 3426.1(d) (West 2016) (UTSA's definition which is limited to "formula, pattern, compilation, program, device, method, technique, or process"). *See also* Letter, *supra* note 249, at 7.

257 Sandeen & Seaman, *supra* note 254.

the duty of loyalty may provide uniformity at the expense of useful state variation. Finally, the DTSA has a controversial remedies provision that allows for the ex parte seizure of "property necessary to prevent the propagation or dissemination of the trade secret that is the subject of the action."[258] This type of provision does not exist under state law, providing claimants under the DTSA with a powerful weapon against potential trade secret disclosure. Ex ante, this provision is the type of strong trade secret norm that can have a chilling effect on the socially beneficial practices of open-sharing described in Part I. On the other hand, the DTSA explicitly preserves the ability of states to refuse to enforce covenants not to compete.[259] The DTSA also appears to reject the inevitable disclosure doctrine by requiring that injunctions be based "on evidence of threatened misappropriation and not merely on the information the person knows."[260] These two provisions—which were missing in early drafts of the DTSA—are likely to be innovation-enhancing because they enable individual states to continue tailoring these two doctrines to their particular local industry profiles.

The most important lesson from research on innovation networks, however, is that it is hard to design a one-size-fits-all trade secret doctrine. Networks of information-sharing emerge as an important factor *for a specific subset of industries*—those that involve complex knowledge, new, fast developing technologies, *and* cross-cutting epistemic networks (often linked to a university, which serves as an anchor tenant).[261] In this subset of industries, fostering *local* information exchange appears to be crucial for the success of clusters. Further, industries of particular types often locate at geographic "centers."[262] Taken together, these two factors suggest that tailoring can additionally take place through state-by-state variation of trade secret law to fit local industry profiles. Because research on innovation clusters is still nas-

258 Defend Trade Secrets Act of 2016, Pub. L. No. 114-153, § 2(b)(2)(A)(i), 130 Stat. 376, 376 (codified as amended in scattered sections of 18 U.S.C.); *see also, e.g.*, Goldman, *supra* note 249 (criticizing the ex parte seizure provision); Levine & Sandeen, *supra* note 249, at 255 (arguing that the ex parte seizure provision could cause a "profound" "chilling effect on innovation and job growth"); Letter, *supra* note 249, at 3 (arguing the ex parte seizure provision "contains significant potential to cause anti-competitive harm, particularly against U.S.-based small businesses, startups and other entrepreneurs").

259 A court may not grant an injunction that: "(I) prevent[s] a person from entering into an employment relationship, and that conditions placed on such employment shall be based on evidence of threatened misappropriation and not merely on the information the person knows" or "(II) otherwise conflict[s] with an applicable State law prohibiting restraints on the practice of a lawful profession, trade, or business." 18 U.S.C.A. § 1836(b)(3)(A).

260 *Id.*

261 *See* Gilson, *supra* note 27, at 627–28 ("However, this balance may well be quite local, depending on the characteristics of particular industries. And because industries are not randomly distributed across jurisdictions, each state's particular industrial population may dictate a different balance.").

262 For example, Boston, San Diego, and Silicon Valley have a high density of biotechnology and IT companies.

cent, it also supports the wisdom of allowing states to experiment with different levels of trade secret protection to fit the profiles of local industries.[263]

Conclusion

This Article has described a crucial aspect of successful innovation in complex technological fields[264] that share a background epistemic community: the transmission of know-how through informal, local networks of innovators that cut across firm boundaries. The centrality of informal knowledge networks for innovation in a subset of technological fields has important implications for two key questions in trade secret law. First, which types of technical information should qualify as a trade secret and which as knowledge belonging to innovators themselves? Second, how should we balance state trade secret protection with the newly created federal cause of action under the Defend Trade Secrets Act? I have argued that in these technological fields the scope of trade secret protection should be construed narrowly—to exclude the kinds of information that are most frequently exchanged through informal knowledge networks: negative know-how and details regarding how to carry out publicly available protocols. Further, the need to tailor trade secret protection to different technological environments highlights the desirability of state experimentation with different levels of protection. A federal cause of action that provides uniformly strong levels of trade secret protection, however, will invariably ratchet up protection everywhere, interfering with states' abilities to design tailored trade secret regimes. Preserving a space for state experimentation, therefore, will also require a narrow interpretation of the scope of trade secret protection under the DTSA.

Knowledge networks can be fragile. Their stability depends in part on the interplay between the strength of trade secret protection and the clashing norms and interests of two groups within innovation firms—managers and inventors. As this Article shows, managers are generally hostile to informal information trading across firm boundaries, even when it is reciprocal and likely to advance overall innovation within a technological cluster.

263 *See* Camilla Alexandra Hrdy, *Patent Nationally, Innovate Locally*, 31 BERKELEY TECH. L.J. (forthcoming 2017). Hrdy has reached a similar conclusion using a different theoretical framework. Hrdy argues that, both under "market preserving" federalism and clustering theories, the power to design trade secret law should be given primarily to states. *See id.* Under market-preserving principles, states are likely to have "better incentives and better information to design trade secret laws that match the needs of specific industries and people within their jurisdictions." *Id.* In turn, "Tiebout clustering" theories suggest that state variation will "lead[ ] to more efficient matching of firms to different jurisdictions and more efficient production within those jurisdictions and overall." *Id.* Note that Tiebout clustering theories are different from the geographic clustering described in this Article. In brief, Tiebout clustering argues for state differentiation on the basis that people tend to cluster to distinct geographic communities based on their shared preferences. *Id.*

264 Complex technological fields are those where technological progress is rapid and knowledge is widely dispersed among firms.

Inventors in these technological areas, on the other hand, are part of epistemic communities with norms of open sharing, who often have personal interests in advancing particular technological frontiers. For these reasons, they are more likely to form networks of informal information trading. In the words of an inventor from the Boston biotechnology cluster, "management thought we had all these great secrets to conceal; the engineers knew that the value was in collaboration."[265]

Knowledge network formation and stability is also mediated by local employee migration. In addition to facilitating spillovers across firms, inventor migration generates local social connections—and a reservoir of trust—that span firm boundaries. In turn, it is this reservoir of trust that facilitates informal and reciprocal informational exchanges across firm boundaries.

Of course, trade secret law is only one piece in a complex system that influences the pace and content of innovation. Modifying the strength of one piece in this system (here, trade secret law) will invariably change how firms use two other available pieces: contracts and patent law. Narrowing trade secret protection may push employers to contract for enhanced secrecy. Yet, this situation is still preferable to strong default trade secret protection in these industries. Contracts entail negotiation and shared agreement. When managers' expectations differ widely from those of innovator communities—as was the case in the innovation clusters surveyed here—contract negotiation will prompt a confrontation between background open-sharing norms and express expectations of secrecy. The outcome of such confrontation depends in part on the strength of the background norms of the epistemic inventor community.

What, then, about patents? The two types of information most commonly exchanged in informal networks (negative know-how and information about publicly available research protocols) are unlikely candidates for patent protection.[266] And even if narrowing the scope of trade secret protection would lead firms to prefer patent law broadly, this is an overall desirable outcome.[267] Trade secrets and patent law differ in one crucial respect. Trade secrets prevent *conversations* about research plans, research protocols, and research results. Patents, on the other hand, enable such conversations. By granting inventors a property right in their innovation while simultaneously encouraging public disclosure of how to make and use it, patents do not shut down informational exchange *about* the innovation but simply pre-

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265 Fleming et al., *supra* note 77, at 539.

266 *See, e.g.*, Reichman, *supra* note 120, at 194–98 (analyzing trade secret protection for unpatentable innovations and industrial know-how in particular).

267 *See, e.g.*, W. Nicholson Price II, *Regulating Secrecy*, 91 WASH. L. REV. 1769 (2016) (analyzing the interplay between patents and trade secrets, and arguing for regulator-enforced disclosure in areas, such as drug-development, that are regulated by an administrative agency).

vent non-patentees from making and using the innovation without permission.[268]

Research on informal information exchanges across firm boundaries is still nascent. While studies suggest that what is exchanged across boundaries is *incremental* know-how, additional research is needed to fully catalogue the types of information that are exchanged informally. Our understanding of the extent of informal information-sharing in different technological regimes also remains incomplete. Although this Article has highlighted the rise of social norms of reciprocity in innovation communities that are anchored to a university, case studies also show that reciprocal know-how trading can happen in other contexts. More research is needed to understand both the breadth of informal know-how trading and how social norms that enable reciprocal sharing emerge, are maintained, and are policed. In turn, a fuller understanding of informational exchange practices across firm boundaries will enable a more contextually sensitive design of innovation policies.

268 This is a highly stylized, "optimistic" or "idealized" view of patent law. In practice, patentees may also seek to shut down conversations about their inventions, and in particular refuse to share details about experimental protocols described in the patent disclosure. *See, e.g.*, W. Nicholson Price II, *Expired Patents, Trade Secrets, and Stymied Competition*, 92 NOTRE DAME L. REV 1611 (2017). Nevertheless, these are failures of the patent system to achieve its stated and desired goals of teaching and disclosure. These goals contrast with the core purpose of trade secret law, which is to aid firms (and individuals) in keeping commercially valuable information secret.