1-2019

Why Do Startups Use Trade Secrets?

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WHY DO STARTUPS USE TRADE SECRETS?

David S. Levine* & Ted Sichelman**

Empirical studies of the use of trade secrecy are scant, and those focusing on startups, nonexistent. In this Article, we present the first set of data—drawn from the Berkeley Patent Survey—on the use of trade secrets by U.S. startup companies in the software, biotechnology, medical device, and hardware industries. Specifically, we report on the prevalence of trade secrecy usage among startups. Additionally, we assess the importance of trade secrets in relation to other forms of intellectual property protection and barriers to entry, such as patents, copyrights, first-mover advantage, and complementary assets. We segment these results by a variety of factors, including industry, company business model, overall revenue, patenting propensity, funding sources, innovation types, and licensing. From this segmentation, we implement a basic regression model and report on those factors showing a statistically significant relationship in the use of trade secrets by startups. Our results point to three major findings. First, trade secrecy serves other important aims aside from first-mover advantage. Second, trade secrets may act both as economic complements and substitutes to patenting. Third, trade secrets may serve as important strategic assets, functioning much in the same manner as patents in terms of licensing and setting the boundaries of the firm.

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INTRODUCTION

Magic Leap is a startup company that is active in the exploding field of augmented reality, head-mounted displays that “superimpose[ ] 3D computer-generated imagery over real world objects.”¹ In 2016, it was one of the first companies to sue under the recently passed Defend Trade Secrets Act (DTSA), the first federal law to provide broad protection for private litigants over trade secrets.² Suits like Magic Leap’s are becoming common, with the “amount and significance” of trade secret litigation “exploding” over the past thirty years.³

Yet, despite this massive increase in the number of suits—and the increasing characterization of trade secrecy as part of the panoply of intellectual property rights protecting innovations—there has been little empirical evidence of its importance.

² See id.; infra note 167 and accompanying text (describing the DTSA). Magic Leap also sued under California trade secret law. See Molinski & Heath, supra note 1.
study on what drives the use and effectiveness of trade secrets, unlike other forms of intellectual property, such as patents.4 Of this small body of trade secret research, very little has even mentioned technology startups.5 This is perhaps even more surprising given that trade secrets are often viewed as a vital mode of protection for a startup’s innovations that may “not otherwise [be] protected by copyright or patent law.”6

In 2008, a team of researchers (including one of us) at UC Berkeley performed a comprehensive study to better understand the role of patenting among startups in the software, medical device, biotechnology, and information technology hardware industries.7 Indeed, one of the leading innovation economists, Bronwyn Hall, refers to it as the “most comprehensive evidence of start-up patenting.”8 Important for this Article, as part of that study, several questions compared patenting to secrecy.9 Although some limited results regarding trade secrecy were published using this dataset,10 much of the data as it relates to secrecy has been either underexplored or wholly unexplored, including the economic relationship between patents and trade secrets,11 the role of trade secrets in promoting first-mover advantage, and

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4 See discussion infra Part II.
5 See discussion infra Section II.A.
6 Jonathan Rubens, Early-Stage IP Protection: A Primer and Overview for Working with the Startup, Bus. L. Today, July 2016, at 1, 3, https://www.americanbar.org/content/dam/aba/publications/blt/2016/07/ip-protection-201607.authcheckdam.pdf; see also Michael Risch, Hidden in Plain Sight, 31 BERKELEY TECH. L.J. 1635, 1637–38 (2016) (contending that where patents are unavailable, software companies even use trade secrecy to protect otherwise “visible program aspects” of their products); Patents or Trade Secrets?, WORLD INTELL. PROP. ORG., http://www.wipo.int/sme/en/ip_business/trade_secrets/patent_trade.htm (last visited Aug. 16, 2017) (“[T]rade secrets may concern inventions or manufacturing processes that do not meet the patentability criteria and therefore can only be protected as trade secrets.”); Tim Sewart, Five Common Legal Mistakes Startups Can Avoid, TECHWORLD (June 8, 2017), http://www.techworld.com/startups/five-legal-terms-all-startups-need-know-about-3659899/ (“Experience tells us that the latter approach (secret; bid for market share) is normally wiser than the former (patents; disclosure) but that businesses’ preoccupation with the former can often leave them mired in delay and cost. Of course, much will depend on the nature of the business or product.”).
9 See discussion infra Part III.
10 See discussion infra Part II.
11 For instance, Hall and her coauthors specifically suggest that more research is warranted and that data from different settings could be helpful for testing “the assumption that patents and secrecy are mutually exclusive and to consider a more complex and realistic scenario in which companies employ different mechanisms to protect the same invention.” Hall et al., The Choice Between, supra note 8, at 419.
the use of trade secrets as strategic intellectual property (IP) assets.\textsuperscript{12} Indeed, after the publication of the Berkeley Patent Survey articles, leading trade secret researcher Ivan Png, as a result of empirical study, called for a “new research agenda—the impact of trade secrets law on (i) entrepreneurship and venture capital, (ii) collaboration, (iii) business and marketing innovation, and (iv) international trade and investment.”\textsuperscript{13} This Article addresses the first three of those items.

As such, this Article makes a significant contribution toward understanding these complex relationships, and thereby helps fill a meaningful void in the literature. Specifically, we make three major theoretical and empirical findings. First, trade secrecy may serve important aims other than extending first-mover advantage.\textsuperscript{14} Second, trade secrets may act as both economic complements and substitutes to patenting.\textsuperscript{15} Third, trade secrets may serve as important strategic assets, functioning much in the same manner as patents in terms of licensing and setting the boundaries of the firm.\textsuperscript{16}

Part I of this Article assesses the current theoretical views on the use of trade secrets, applying them in the context of technology startups. Part II then explores the existing empirical research regarding trade secrets, noting the relative paucity of work focused on startups. Part III begins by describing the Berkeley Patent Survey, including its methods and dataset. It then presents the major results as they concern trade secrecy, first descriptively, and then in the form of several regression models. Part IV assesses the results, describing the study’s major implications for trade secrecy theory and empirical research.

I. Existing Theories of Why Startups Use (and Don’t Use) Trade Secrets

As noted earlier, the literature contains a variety of theories attempting to explain why companies choose to use trade secrets (or not).\textsuperscript{17} Less prevalent are theories focused on startups.\textsuperscript{18} Here, in order to provide context for our empirical study, we draw from the smaller literature on startups and adapt from the larger, more general literature to present a theory as to why startups use (and do not use) trade secrecy.\textsuperscript{19} We focus on a startup’s deci-

\textsuperscript{12} See discussion \textit{infra} Part IV.
\textsuperscript{14} See discussion \textit{infra} Section IV.A.
\textsuperscript{15} See discussion \textit{infra} Section IV.B.
\textsuperscript{16} See discussion \textit{infra} Section IV.C.
\textsuperscript{17} See discussion \textit{supra} Introduction (describing several prominent theories of why firms use trade secrets).
\textsuperscript{18} See discussion \textit{infra} Sections I.A–B. (drawing primarily from studies focused on companies as a whole).
\textsuperscript{19} See discussion \textit{infra} Sections I.A–B. (presenting a set of reasons as to why startups use (and do not use) trade secrets).
sion to choose trade secrecy as an appropriation mechanism in addition to (i.e., as an economic “complement”) or in place of (i.e., as an economic “substitute”) to other forms of intellectual property and barriers to competition, such as patents, copyrights, and lead-time advantages.20

A. Reasons Why Startups Use Trade Secrecy

While patents and copyrights are mandated by the U.S. Constitution,21 the origins of trade secrecy trace to the common law.22 There are two core elements for trade secret infringement under state law: “(1) the information qualifies as a ‘trade secret,’ and (2) the defendant acquired, used, or disclosed the information in breach of confidence or by other improper means.”23 The Restatement (Third) of Unfair Competition has articulated a similar framework for trade secrecy.24 Trade secrecy applies to a range of information, including recipes,25 software code,26 customer lists,27 algorithms,28

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20 N. GREGORY MANKIW, PRINCIPLES OF ECONOMICS 98 (7th ed. 2015) (“[S] ubstitutes are goods that are typically used in place of one another, such as hamburgers and hot dogs. . . . Conversely, complements are goods that are typically used together, such as computers and software.”).


22 See Sharon K. Sandeen, The Evolution of Trade Secret Law and Why Courts Commit Error When They Do Not Follow the Uniform Trade Secrets Act, 33 Hamline L. Rev. 493, 496 (2010) (“For a variety of reasons . . . the evolution of trade secret law shifted from the crucible of the courtroom and the common law process to the uniform lawmaking and legislative processes.”).


24 RESTATEMENT (THIRD) OF UNFAIR COMPETITION § 39 (AM. LAW INST. 1995) (defining a “trade secret” as “any information that can be used in the operation of a business or other enterprise and that is sufficiently valuable and secret to afford an actual or potential economic advantage over others”).

25 See generally Babak Zarin, Knead to Know: Cracking Recipes and Trade Secret Law, 8 Elon L. Rev. 183 (2016) (analyzing the evolution of the cooking industry standards in the context of copyright, patent, and trademark law).


and other technical information. Perhaps the most well-known example of the “best-kept trade secret[ ] in the world” is the recipe for Coca-Cola.

1. To Maintain Lead-Time Advantage and Prevent Competition

“Lead-time” or “first-mover” advantage occurs when a company enters the market earlier than competitors, which often allows the company to acquire a dominant market share for a particular product or service. Although startups can maintain a lead-time advantage simply because of the inherent failure of competitors to innovate, a primary reason for choosing trade secrecy is to extend a lead-time advantage by preventing the disclosure of specific information that provides the advantage. For instance, to a large degree, Google—an early pioneer in online search engines—has been able to maintain its dominance by keeping key details of its search algorithms a trade secret.

Theoretical modeling supports this conclusion. For instance, Alexandra Zaby has constructed an economic model that finds when a technological first-mover advantage is large, inventors will often use secrecy in an effort to...
extend the lead. Yet, the model also shows that when reverse engineering is straightforward—such as in the pharmaceutical industry—companies will tend to rely upon patents to protect a first-mover advantage.

Beyond first-mover advantage for a single company, sometimes a small number of incumbent companies may use trade secrets to maintain an oligopoly for a product or service merely by excluding potential competition. Here, the mechanism is similar to that of maintaining a first-mover advantage—by preventing third parties from obtaining critical information, the incumbents enjoy supracOMPETITIVE proFits flowing from the lack of competition.

2. Patent Protection Is Unavailable

As just noted, sometimes patents are a better mechanism to maintain a lead-time advantage or to prevent competition than trade secrets, particularly when reverse engineering or independent invention is likely. However, in many instances, patent protection is unavailable for an invention—for instance, because it is too abstract or too obvious of an idea to be patentable.

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36 See Zaby, supra note 35, at 160 (“In an industry sector with a high propensity to patent, such as Pharmaceuticals, the easiness of reverse engineering is rather high so that the effective headstart of an inventor is low.”).

37 See Katarzyna A. Czapracka, Antitrust and Trade Secrets: The U.S. and the EU Approach, 24 Santa Clara Computer & High Tech. L.J. 207, 236 (2008) (“Licensing of trade secrets (or know-how), just as patent licensing, is generally pro-competitive; it allows dissemination of technology and its fuller exploitation. . . . But the license can also be a mere sham to cover price fixing or territory sharing between competitors.”).

38 See Wajisran & Garcia-Valero, supra note 31, at 10 (“Entrepreneurs expect supernormal profits by enjoying some kind of exclusive market power over their inventions.”); Douglas C. Lippoldt & Mark F. Schultz, Uncovering Trade Secrets—An Empirical Assessment of Economic Implications of Protection for Undisclosed Data 8 (OECD Trade Policy Papers, No. 107, 2014) (“A further incentivising effect noted in the literature is the role that trade secrets may play in conferring competitive benefits. . . . Firms may invest in developing trade secrets because the prospect of supra-competitive profits motivates them to do so.”).

39 See Zaby, supra note 35.
ble.40 Thus, another important reason for using trade secrecy is as a substitute for patent protection.41

Historically, perceived patent unavailability has been exacerbated by the “legal uncertainty” surrounding the availability of patent protection, which drives firms to trade secrecy.42 Additionally, a perceived inability to reduce an innovation to writing can also be a hindrance.43 By contrast, trade secrecy requires no administrative hurdles and no reduction to writing; one either meets the standard or one does not, and no administrative agency ever decides whether those elements are met.44

40 See 35 U.S.C. §§ 101, 103 (2012) (putting forth the rules for unpatentability of obvious and abstract inventions); see also Risch, supra note 31, at 12 (“Unlike a patent, information need not be unique, novel, or non-obvious to be protected.”).

41 EUROPEAN COMM’N, STUDY ON TRADE SECRETS AND CONFIDENTIAL BUSINESS INFORMATION IN THE INTERNAL MARKET 124 (2013) [hereinafter EUR. COMM’N, Study on Trade Secrets], http://ec.europa.eu/internal_market/ipenforcement/docs/trade-secrets/130711_final-study_en.pdf (“The second most important reason . . . [why businesses rely on trade secrets rather than on other intellectual property rights] is the lack of eligibility (30% [positive responses]).”).

42 See Serge Pajak, Do Innovative Firms Rely on Big Secrets? An Analysis of IP Protection Strategies with the CIS 4 Survey, 25 ECON. INNOVATION & NEW TECH. 516, 528 (2016) (“The notion that firms tend to prefer secrecy to protect their innovations because of the legal uncertainty surrounding IP rights has been suspected for long and has led to several patent system reform propositions.”); see also James J. Anton & Dennis A. Yao, Little Patents and Big Secrets: Managing Intellectual Property, 35 RAND J. ECON. 1, 1 (2004) (“Surveys of U.S. firms found that a substantial fraction of patentable inventions were not patented (Mansfield, 1986) and that secrecy was viewed as more important than patenting for appropriability (Cohen, Nelson, and Walsh, 2000).”); Josh Lerner, Using Litigation to Understand Trade Secrets: A Preliminary Exploration 3 (Aug. 7, 2006) (unpublished manuscript), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=922520&rec=1&srcabs=1090933&alg=1&pos=53 (noting that firms should keep important discoveries secret, especially where enforcement of property rights is limited). Indeed, not understanding patent law or the patent option can itself drive firms to secrecy. See Christian Helmers & Mark Rogers, Does Patenting Help High-Tech Start-Ups?, 40 RES. POL’Y 1016, 1026 (2011) (“[A] substantial lack of understanding of the IP system particularly among small companies . . . may explain why the proportion of patentees is low.”). Lerner noted that firms that have little experience dealing with “formal” protections, or that infrequently innovate, will use secrecy over patents. Lerner, supra, at 5 (noting firms that “have little experience with seeking formal protection” or “that innovate infrequently may consequently eschew [formal] protection, and rely instead on trade secrecy”); see also David D. Friedman et al., Some Economics of Trade Secret Law, 5 J. ECON. PERSP. 61, 64 (1991) (“The Patent Office correctly refuses the patent—and the inventor correctly uses trade secret protection instead.”).

43 See Nuria González-Alvarez & Mariano Nieto-Antolín, Appropriability of Innovation Results: An Empirical Study in Spanish Manufacturing Firms, 27 TECHNOVATION 280, 284 (2007) (“Codification of knowledge refers to the fact that knowledge may be converted into information using formulas, diagrams, numbers or words. . . . The patent system is, therefore, more effective when protecting [explicit or codified] knowledge.”); id. (“[P]rotecting tacit knowledge, which is impossible to patent as it cannot be reduced to information, requires the use of industrial secret as a defence mechanism.”).

44 See David S. Levine, Secrecy and Unaccountability: Trade Secrets in Our Public Infrastructure, 59 FLA. L. REV. 135, 156–57 (2007) (noting the “infinite duration” of Coca-Cola’s
Perceived lack of patentability has been heightened especially for software, business method, and biotechnology inventions after the U.S. Supreme Court’s recent decisions in *Mayo Collaborative Services v. Prometheus Laboratories, Inc.*,45 *Ass’n for Molecular Pathology v. Myriad Genetics, Inc.*,46 and *Alice Corp. v. CLS Bank International*,47 driving many innovators, including startups, away from patents and toward trade secrecy.48 Although the effects of these cases are still in flux, it is safe to assume that software and biotechnology startups will veer toward trade secrecy until there is more clarity about the *Mayo-Myriad-Alice* standard of patent eligibility.49

While the *Mayo-Alice* standard has erected a “not welcome” sign for many software and biotechnology inventions, trade secrecy welcomes the same inventions with open arms.50 Specifically, trade secret protection is available for information that is not generally known to those in the industry, is capable of adding economic value to the secret holder, and is subject to reasonable precautions under the circumstances to prevent its disclosure.51 This means that the eligible subject matter for trade secrets has a much wider formula, maintained as a trade secret rather than patent of limited duration, because Coca-Cola was able to continually meet the elements of a trade secret).

45 566 U.S. 66, 73 (2012) (“[T]he steps in the claimed processes (apart from the natural laws themselves) involve well-understood, routine, conventional activity previously engaged in by researchers in the field.”).
46 569 U.S. 576, 580 (2013) (holding that Myriad Genetics’s patents on naturally occurring isolated DNA sequences are invalid because “a naturally occurring DNA segment is a product of nature and not patent eligible”).
47 134 S. Ct. 2347, 2352 (2014) (“[M]erely requiring generic computer implementation fails to transform that abstract idea into a patent-eligible invention.”).
49 See Robert W. Esmond et al., *A Best Kept Secret: AIA Allows Patenting of Trade Secrets*, BLOOMBERG BNA (Feb. 12, 2016), http://www.bloomberglaw.com/exp/eyJpZCI6IkEwSDhXNItc0UDc/anM9MCZzdWJyYlJpcHRpb250eXBlPWJvYXBlO2VzczpcNlIzT0yMDE2MDIzMCZjYW1vYWhnbc (“Increased market competition and recent Supreme Court decisions limiting subject matter patent eligibility have caused many companies to question whether they should file for patent protection, rely on trade secret protection, or both.”).
50 See Simon & Sichelman, *supra* note 34, 411–12 (“The Court adopted a similar rationale in *Alice Corp. v. CLS Bank International*, where it applied the *Mayo* test to abstract ideas, and like *Mayo*, called into question the patentability of a large class of inventions, here software.”).
51 See Lemley, *supra* note 31, at 317 (“A trade secret claim can be broken down into three essential elements.”).
scope than patents, covering business plans, customer lists, so-called “negative know-how,” and certainly software and biotechnology inventions.

The America Invents Act (AIA) is another substantive change in patent law that potentially makes trade secrecy more attractive. These changes potentially narrow the scope of prior art to include only what is available to the public and may even allow the patenting of trade secrets years after they have been exploited commercially. Although one initial decision of the Federal Circuit casts some doubt on whether the courts will interpret the AIA in such a manner, these possibilities still remain open questions.

3. Patent Protection Is Too Costly, Weak, or Difficult to Enforce

Startups “may be subject to a different cost-benefit scheme when deciding to file for a patent.”

Obtaining and asserting patents is expensive,

\[\text{See Wajsman & Garcia-Valero, supra note 31, at 14 ("[T]he range of information that can be kept as a trade secret is indeed much broader by definition.").}
\]

\[\text{See id. at 35 tbl.6 (showing how the "[m]anufacture of computer, electronic and optical products" industry has one of the highest trade secret use percentages (76.9%).}]
\]

\[\text{See Lemley, supra note 31, at 331 (explaining the subject matter limitation of patent law for a firm's valuable information); Levine, supra note 44, at 155 ("[V]irtually all information that may, in some more than trivial way, have any value to a company could qualify as a trade secret."); see also Wajsman & Garcia-Valero, supra note 31, at 13 ("Commercial trade secrets may consist of customer and supplier lists, business methods and strategies, and cost and price information.").}
\]

\]

\[\text{See 35 U.S.C. § 102(a)(1) (2012) ("[T]he claimed invention was patented, described in a printed publication, or in public use, on sale, or otherwise available to the public before the effective filing date of the claimed invention . . . .") (emphasis added); Manzo, supra note 55, at 501 ("The PTO concluded that the revised defense has no direct impact on trade secret law and that a prior user (whether the use is secret or not) who meets the statutory provisions of 35 U.S.C. § 273 can continue to practice the subject matter despite a later patent that the user otherwise would infringe.").}
\]

\[\text{Helsinn Healthcare S.A. v. Teva Pharm. USA, Inc., 855 F.3d 1356, 1371 (Fed. Cir. 2017) ("[A]fter the AIA, if the existence of the sale is public, the details of the invention need not be publicly disclosed in the terms of sale."); cert granted, 138 S. Ct. 2678 (2018).}
\]

\[\text{Ted Sichelman & Stuart J.H. Graham, Patenting by Entrepreneurs: An Empirical Study, 17 MICH. TELECOMM. & TECH. L. REV. 111, 117 (2010); see also Wajsman & Garcia-Valero, supra note 31, at 32 (showing figures indicating that large innovating companies tend to use trade secrets at a much higher percentage than small- and medium-sized enterprises).}
\]

\[\text{See Aija Leiponen & Justin Byma, If You Cannot Block, You Better Run: Small Firms, Cooperative Innovation, and Appropriation Strategies, 38 Res. Pol'y 1478, 1486 (2009) ("[P]atents are too expensive to originate and defend for many small firms.").}
\]
and dealing with patent challenges can be equally cost prohibitive.\(^{60}\) Alternatively, trade secret protection vests almost immediately after meeting three essential requirements,\(^ {61}\) does not require an attorney to ensure protection, and requires no filing fees.\(^ {62}\) Patent litigation can also cost as much as three times as much as trade secret litigation—with “a median of $5 million per side in legal fees for large cases.”\(^ {63}\) A major factor for startups, the cost of obtaining a patent, will depend on the technology, claims, and patent prosecutor, but can range from $10,000 to $50,000,\(^ {64}\) and maintenance fees in the United States alone cost roughly $3000 to $13,000, depending on how large the startup is over the life of the patent.\(^ {65}\)

Trade secrets, on the other hand, include the expense of sufficient precautions, such as nondisclosure agreements, installation of physical safeguards, and the expense of litigation\(^ {66}\) in the event precautions fail.\(^ {67}\) Nonetheless, these costs will generally be less than obtaining, defending, and asserting patents.\(^ {68}\) Therefore, minor inventions may not be worth the cost of obtaining a patent.\(^ {69}\)

\(^{60}\) See Lerner, supra note 42, at 4 (“Firms with less capital market access may rely on trade secrecy rather than on formal forms of intellectual property protection that may be subject to costly challenges.”).

\(^{61}\) See Lemley, supra note 31, at 317 (“A trade secret claim can be broken down into three essential elements.”).

\(^{62}\) See id. at 313 (“[T]rade secrecy is cheaper and quicker to obtain, since it doesn’t require government approval . . . .”; Risch, supra note 31, at 36 (“[T]rade secrets are much cheaper to obtain and do not grant the absolute exclusive right that patents do.”).

\(^{63}\) Lemley, supra note 31, at 331 (explaining why small companies view trade secrecy as more cost-effective); see also Graham et al., supra note 7, at 1315 (“Startups may be particularly sensitive to accusations of infringement because they are likely to experience resource constraints when faced with the costs of funding a suit, estimated for most suits to be between $3 million and $6 million per litigant through appeal.”).

\(^{64}\) See Derek E. Bambauer, Secrecy is Dead—Long Live Trade Secrets, 93 DENN. L. REV. 833, 836 (2016) (“[T]wo 2013 surveys estimate the prosecution cost for a moderately complex patent at roughly $10,000.”); Graham et al., supra note 7, at 1311 (“[T]he average out-of-pocket cost for a respondent firm to acquire its most recent patent was over $38,000.”).


\(^{66}\) See Castellaneta et al., supra note 33, at 836 (discussing how the number of trade secret theft cases doubled between 1988 and 1995, and doubled again between 1995 and 2004, with the expectation of it doubling again in 2017).

\(^{67}\) See Bambauer, supra note 64, at 836 (posing examples for precautions taken by companies to protect their secrets).

\(^{68}\) See Graham et al., supra note 7, at 1262 (“[T]he costs of prosecuting and enforcing patents are a substantial barrier to technology entrepreneurs attempting to access the patent system.”).

\(^{69}\) See Josh Lerner, An Introduction to Patents and Trade Secrets, (Harvard Bus. Sch., Background Note No. 295-062, 2006), http://www.hbs.edu/faculty/Pages/item.aspx?num=7559 (“[T]he innovation may be relatively minor, and hence the cost of filing and prosecuting an application may exceed the benefit of patent protection.”); see also González-
Startups may view patents as particularly unattractive, as they have “fewer revenue streams to protect or production costs to cut, which can make the benefit of a patent seem remote.” In this regard, Anthony Arundel speculates that small firms, except those in the high-technology fields, are less likely to develop patentable inventions, and instead generate incremental improvements that are not worth patenting, but that are potentially protectable by trade secrecy. Further, “because startups may be [research and development] specialists—doing less sales and marketing in their early life—they may invent a diverse set of potential and not yet marketable products in a short period of time.”

Patents are simply not an adequate substitute for startups that do not have the same financial backing as larger, more established firms. Thus, it has been argued that an important goal of trade secrecy is, paradoxically, for “businesses to spend less money protecting secret information.” Professor Michael Risch argues that “[b]y allowing the creator exclusive use, the creator can more readily recoup [the] cost[ ] of creation.”

4. To Provide Protection Prior to and Complementary with Patenting

Although patents and trade secrets are often considered mutually exclusive substitutes, they are often used as complementary strategies, espe-

Álvarez & Nieto-Antolín, supra note 43, at 285 (noting that innovations based on “minor incremental improvements” are not worth patenting).

70 Sichelman & Graham, supra note 58, at 117 (citing Ronald J. Mann, Do Patents Facilitate Financing in the Software Industry?, 83 Tex. L. Rev. 961, 985 (2005)).

71 See Arundel, supra note 32, at 613 (“[M]any small firms, with the exception of those that are pursuing a high-technology strategy, could be less likely than large firms to develop patentable innovations. Instead, many of their innovations could be based on minor incremental improvements that are not worth patenting.”); see also Joshua S. Gans & Scott Stern, Endogenous Appropriability, 107 Am. Econ. Rev. 317, 321 (2017) (“[The] appropriability regime governing an innovation depends not only on the instruments available to an innovator to protect private returns, but how those instruments interact with each other as part of the firm’s entrepreneurial strategy.”).

72 Sichelman & Graham, supra note 58, at 117; see also Wajszman & García-Valero, supra note 31, at 35 (showing how the “[s]cientific research” industry has the highest percentage for the use of trade secrets (79.3%) in the forty-six industries listed for EU countries).

73 See Lemley, supra note 31, at 331 (discussing why startups “rely heavily on the incentive to invent provided by trade secret law”).

74 Risch, supra note 31, at 5. But cf. Levine, supra note 44, at 152, 180 (noting that particularly in industries like public infrastructures (i.e., voting machines), trade secrecy may encourage more secrecy at the expense of public knowledge and access).

75 Risch, supra note 31, at 27. On the other hand, startups may engage in patent for signaling, defensive, or other strategic reasons, and in some instances, these secondary benefits may offset the higher costs of patenting. See Sichelman & Graham, supra note 58, at 120–30 (examining these secondary reasons to patent by startups).

76 See Gans & Stern, supra note 71, at 317 (“[T]here is an] interplay between control and execution as alternative routes to appropriability.”).
cially for large portfolios of intellectual property. First, a strong trade secret protection program is often important during the “early stages of development . . . [to] protect information that offers a competitive advantage.” During this development phase, a startup typically determines whether the idea is ready for commercialization and whether a new method of protection, such as patents, might be needed.

This is especially so for incremental innovation among startups, where the value of the innovation may be relatively small, and significant time is needed to assess whether more costly protection, such as patenting, is warranted. Thus, keeping information secret in the research and development (R&D) stage is a particularly strong reason for startups to use trade secrecy, especially if the trade secret is the firm’s sole asset. Of course, the damage to a startup from losing valuable R&D trade secrets to a competitor—like, for example, losing the core trade secret when the R&D vice president steals them and brings them to a larger competitor—can be profound. Thus, startups must invest in robust protection programs.

77 See Wajsmann & García-Valero, supra note 31, at 53 (“[C]omplementarity used here really refers to common adoption of trade secrets and patents.”).
78 See infra Part II (discussing empirical evidence that suggests that patents are not an effective tool in most industries, especially not taken alone).
80 See id. (posing important questions for firms to address when deciding to file for patent protection); see also Wajsmann & García-Valero, supra note 31, at 17 (“Firms may also combine patenting and secrecy in a way that enables them to keep the codified part of an invention secret, whilst maintaining the option of later patenting the invention.”).
81 See EUR. COMM’N, Study on Trade Secrets, supra note 41, at 2 (“With specific focus on small and medium-sized enterprises (SMEs), trade secrets appear of particular importance because innovation in this segment tends to be more incremental in nature . . . .”); Wajsmann & García-Valero, supra note 31, at 14 (“[Trade secrecy] applies to innovation in the early stages of [the] innovative process.”).
82 See Heidi Olander et al., What’s Small Size Got to Do with It? Protection of Intellectual Assets in SMEs, 13 INT’L J. INNOVATION MGMT. 349, 357 (2009) (“[I]t can be assumed that the protection is targeted more on protecting existing knowledge assets—and thus premises for future innovation—than on protecting innovation output.”). In this regard, stricter rules that require disclosure prior to patent issuance may benefit large firms rather than startups, because the large firms are more likely to have the funds to obtain a patent. See id. at 356 (“N ew disclosure rules benefiting bigger firms may be disadvantageous to SMEs as they force them to expose the details of their inventions before the patents have been granted . . . .”). However, Stuart Graham and Deepak Hegde note that despite the seeming benefits of electing not to publish prior to patent issuance for small companies—which is feasible for firms that only file in the United States—very few elect it. See Stuart Graham & Deepak Hegde, Disclosing Patents’ Secrets, 347 SCI. 236, 236 (2015) (“All inventor types are much more likely to choose pregrant disclosure over secrecy (SM). Conditional on U.S.-only patenting, small U.S. inventors prefer pregrant disclosure, and are no more likely than large U.S. entities to select secrecy (16.9% versus 16.4% . . . .”).
83 See, e.g., Joe Carlson, Medical Device Executive Pleads Guilty to Stealing Trade Secrets, STAR TRIB. (May 9, 2017), http://www.startribune.com/medical-device-executive-pleads-guilty-to-stealing-trade-secrets/421793043/ (noting that the defendant, who pled guilty to a criminal charge of trade secret misappropriation, “was vice president of research and

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Similarly, trade secrecy can work in tandem with existing patents. For instance, IP and lead time can be complementary, and startups may “protect innovations by concentrating on safeguarding innovative input, rather than innovations as output.” This concept ties in with the complementary strategy analysis described earlier, especially as biotechnology and software startups look for opportunities to sell or license to firms that will market their trade secret. Indeed, innovation can be protected by both a “product patent” and a “process trade secret,” and are therefore complements, although a single bit of knowledge cannot be protected by both a patent and trade secret.

Moreover, even for pure product patents, it is often possible in practice to withhold key details of the invention, yet still obtain patent protection. Related, a firm may improve an existing patented invention, maintaining the improvement as a trade secret. In this regard, there is no obligation for patent holders to continuously update their patent disclosures as they

development at Lutonix from 2007 to 2015, a position that gave him access to the company’s proprietary designs for drug-coated balloons.

84 See Wajsmans & Garcia-Valero, supra note 31, at 14 (“[T]rade secrets may be used in combination with other IP protection mechanisms to protect complex innovations . . . .”).
85 See Wajsmans & Garcia-Valero, supra note 31, at 8 (“Innovating firms often use both patents and trade secrets to protect their innovations . . . .”); Heidi Olander et al., Reasons for Choosing Mechanisms to Protect Knowledge and Innovations, 52 MGMT. DECISION 207, 213 (2014) (“[I]nformal and formal mechanisms . . . may also be complementary (e.g. IPRs and lead time).”).
86 Olander et al., supra note 82, at 366.
87 See Czapracka, supra note 37, at 217 (“[S]ecret know-how concerning the implementation of a patented invention is often licensed with patents, which indicates that there is some level of symbiosis between patents and know-how.”).
88 Marcus Holgersson, Patent Management in Entrepreneurial SMEs: A Literature Review and an Empirical Study of Innovation Appropriation, Patent Propensity, and Motives, 43 R&D MGMT. 21, 25 (2013) (“[A]n innovation can be protected by both a product patent and a process trade secret, and that patents and trade secrets therefore are not mutually exclusive but rather important complements. Nevertheless, it can be argued that each single bit of knowledge cannot be protected by both a patent (which requires information disclosure) and a trade secret (which requires information nondisclosure).”); see also Wajsmans & Garcia-Valero, supra note 31, at 17 (“[F]irms may also choose to mix both strategies at the level of individual innovations by protecting some elements of a technology through patents and keeping others secret . . . .”).
89 See Wajsmans & Garcia-Valero, supra note 31, at 20 (“Graham (2004) argues that firms may keep the codified part of an invention secret, while maintaining the option to later patent the invention.”); Simon & Sieliman, supra note 34, at 377 (“[B]ecause the patent disclosure requirements are not always rigorous, inventors may sometimes be able to keep certain aspects of an invention secret, yet still receive a patent to the invention as a whole.”).
90 See Bone, supra note 23, at 265 (“[T]he economic goal is to internalize just enough of the social value so that prospective inventors will invest optimally in creative activity given the social costs.”).
improve the underlying invention. In yet another strategy, firms that can patent so called data-generating inventions obtain a patent on a process or system that generates data, then retain the data as a trade secret, often effectively extending the twenty-year term of the underlying patent. All of these strategies underscore that patents and trade secrets are not always substitutes for one another, even after patent issuance, contrary to the preponderance of existing empirical literature.

5. To Assist in Financing and Financial Exit

Holding patents can assist startups in obtaining financing and improving the possibility and quality of an acquisition or initial public offering. Similarly, one can hypothesize that maintaining trade secrets—namely, valuable information that is sufficiently protected to be afforded trade secret protection—can benefit financing and financial exit. When a startup’s managing partner has a strong customer list, the big names on the list may encourage others to back the budding startup. Another prime example is a secret for the process of making goods at a lower cost, allowing the startup to spend a great deal less to produce twice as many of the same goods as a competing company. An investor’s access to this information would encourage financial backing on the front end, and a possibly lucrative financial exit on the back end. Therefore, knowledge (or lack thereof) can impact whether an investor will choose to invest in and/or acquire a startup.

However, one major difference between patents and trade secrets is that because patents are eventually public documents, one can argue that they serve a signaling function—namely, identifying the value of technological

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91 See, e.g., Simon & Sichelman, supra note 34, at 385 (“[I]nventors are under no duty to update their disclosures after they file for a patent application.”).
92 See id. at 379 (“Even after the patent term ends, the data-generating patent holder may continue to benefit from the de jure lead time advantage secured by the prior patent in its compilation of data.”).
93 See id. at 384 (“Patents and trade secrets are traditionally considered economic substitutes . . . . However, a handful of scholars have recognized that patents and trade secrets may sometimes act as economic complements, because patent law does not always require full disclosure of the invention.”).
94 See Graham et al., supra note 7, at 1303 (“[P]atents play an important role in the financing of many startup companies, both during the initial stages and subsequent development of the firm, and also at the liquidity or exit event.”); Sichelman & Graham, supra note 58, at 113 (“[S]tartup and early-stage companies seek[ ] to use patents to attract financing and to improve their chances of being acquired or going public.”).
95 See Levine, supra note 44, at 139 (“[T]he use of secrecy as a core business tool is increasing in use and importance.”); Sichelman & Graham, supra note 58, at 166 (“[Firms] use . . . patents to secure capital and improve exits . . . .”).
96 See Risch, supra note 31, at 28 (“Knowing who to contact will reduce costs of sales vis à vis a company’s competitors.”).
97 See id. (“Producers compete with other food and widget makers, and they still have price competition.”).
98 See id. (discussing how trade secrets must have a competitive value, and cost reduction is one of them).
assets—that may not be served by trade secrets.\textsuperscript{99} Thus, to the extent that the benefit to startups of holding patents for financing and exit is driven by signaling value, then trade secrets may not afford these benefits.\textsuperscript{100} On the other hand, there are strong arguments that patents assist financing and exits beyond mere signaling value, and to the extent trade secrets serve many of the same nonsignaling functions as patents, then presumably trade secrets would also benefit startups in these financial events.\textsuperscript{101}

6. To Prevent Employees from Working at Competitors

Startups are often faced with key employees wishing to depart for a competitor or to form a new company.\textsuperscript{102} A noncompetition agreement, which prevents employees from working at a competitor for a specified period of time after termination or resignation, is the primary mechanism to stem this leakage of “human capital.”\textsuperscript{103} Where enforced, they can be very effective at preventing employees from working for a competitor.

However, in a few states, noncompetition agreements are precluded by law, at least in certain situations, or are subject to various limitations.\textsuperscript{104} In these states, trade secrets and patents can be used to mimic the preclusive effects of noncompetition agreements by creating significant penalties for bringing proprietary information to a new employer.\textsuperscript{105} Specifically, if an

\textsuperscript{99} See Clarisa Long, Patent Signals, 69 U. Chi. L. Rev. 625, 642 (2002) (“[T]he signaling value to the patentee may be the extra capital it is able to raise in capital markets because of the information conveyed by the patent.”).

\textsuperscript{100} See Graham et al., supra note 7, at 1306 (“It is widely held that VC investors rely on patents in their investment decisions . . . .”); see also Sichelman & Graham, supra note 58, at 161 (“[T]his finding may support the view that investor sentiment is primarily driven by patents’ signaling qualities.”).

\textsuperscript{101} See Graham et al., supra note 7, at 1306–07 (“[P]atents tend to provide sufficient freedom to operate, allowing a company to develop and commercialize its embryonic products. . . . [And allow the investors] to enjoy these IP rights as residual claimants should the venture fail.”).

\textsuperscript{102} See generally Lemley, supra note 31, at 315 (discussing how the circumstances in which an employee may continue her business after departing her employer is still debated today).

\textsuperscript{103} Wajsman & Garcia-Valero, supra note 31, at 15 (“[Trade secrets] require explicit non-disclosure and non-compete clauses in employee contracts which may inhibit employee mobility or trigger payment of indemnification if enforceable . . . .”); Viva R. Moffat, Making Non-Competes Unenforceable, 54 Anz. L. Rev. 939, 940 (2012) (defining “non-competition agreements” as “agreements by employees not to compete with their employers following the termination of employment”); see also Castellaneta et al., supra note 33, at 838 (discussing how fear of trade secret misappropriation constrains the amount of knowledge a former employee can transfer to a new employer).


\textsuperscript{105} See id. at 9 (“A firm may use patents to protect against knowledge leakage through employee movement . . . .”).
employee seeks to depart to a competitor or to form a new company, but the information in the employee’s possession cannot legally be put into practice, it will in principle provide a strong incentive for the employee to remain at the current employer. Thus, although there is some debate about whether patents or trade secrets are more effective in this role, there is no doubt that trade secrecy can serve such a purpose and thus help promote the esprit de corps of a well-run startup (as compared to the use of typically more restrictive noncompetition agreements).

7. To Generate Licensing Revenues

Typically, licensing of technological inventions occurs via the licensing of patents. In this instance, a license generally provides a third party a right to make, use, or sell the patented invention in return for a fee. Because the invention being licensed is disclosed in a patent, a prospective licensor generally can disclose the invention to a prospective licensee as part of the initial licensing offer without fear that the invention will be used absent remuneration. Either the prospective licensee pays for its use via a license, or in the event the licensee uses the invention without authorization,

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106 See id. ("A patenting strategy converts any departing employee into an encumbered asset that is less attractive to competitors, will receive lower offers from competitors, and can therefore be retained at a lower cost."); Castellaneta et al., supra note 33, at 838 ("In over 75 percent of trade secret cases in U.S. state courts and over half the cases in U.S. federal courts, the alleged misappropriator was a former employee . . . .").

107 Compare Emilie-Pauline Gallié & Diégo Legros, French Firms’ Strategies for Protecting Their Intellectual Property, 41 Res. Pol’y 780, 782–83 (2012) ("Analysing the link between human resource practices and the choice between patenting and secrecy . . . the introduction of strategies to secure employee loyalty (in other words, to reduce job mobility) leads to greater use of trade secrets than patents.").

108 See, e.g., Gallié & Legros, supra note 107, at 785 ("This strategy of non-statutory means of protection also requires the development of employee loyalty. And indeed, these firms do develop human resources strategies to retain employees.").

109 See Robin Cooper Feldman & Mark A. Lemley, Do Patent Licensing Demands Mean Innovation?, 101 Iowa L. Rev. 137, 139 (2015) ("It is the technology being sold; the patents accompany the sale of the technology.").


111 See Michael J. Burstein, Exchanging Information Without Intellectual Property, 91 Tex. L. Rev. 227, 229 (2012) ("If information is subject to a patent or a copyright, then it can be disclosed without fear that it will be taken without compensation."); Sichelman & Graham, supra note 58, at 129 ("Because a patent can often prevent copying by third parties, a patent may effectively serve as a non-negotiable form of non-disclosure agreement (NDA), usually protected by broad injunctive relief.").
it pays for its use in a patent infringement action (assuming the patent is valid).112

Indeed, Kenneth Arrow postulated that patents can solve what has been dubbed the “information disclosure paradox” — namely, that in order for the holder of value information to sell it to another party, it must disclose the information to that party, but once the information is disclosed, the other party can expropriate it without any legal repercussions.113 Patents help to overcome the paradox by providing the discloser of the information a legal cause of action against the recipient who uses it without authorization.114 Trade secret protection, on the other hand, would not provide such protection in theory, because all protection is vitiated as soon as the information is voluntarily disclosed to a third party not under an obligation to maintain the information as a secret.115 Of course, the holder of the information can attempt to secure a nondisclosure agreement (NDA) with the recipient, but many potential licensees refuse to sign such agreements for fear of a lawsuit over information the recipient already possessed.116

However, Michael Burstein has cast doubt on the traditional theory of information disclosure — and, in turn, the bite of Arrow’s information disclosure paradox — because he explains that in many transactions, information can be disclosed in seriatim, like the layers of an onion being peeled back, so as to reveal the most valuable information only after lengthy discussion and negotiation.117 When information can be disclosed in this fashion, trade secret law still plays a critical role by protecting the core of the most valuable information from being expropriated absent remuneration.118 Thus, if the recipient agrees to be bound by a confidentiality agreement, or if informa-

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112 See Michael Risch, Licensing Acquired Patents, 21 GEO. MASON L. REV. 979, 985 (2014) (“Some patent owners, including acquirers, might recount how they approached potential licensees but were rejected, and how they later had to sue for infringement.”).

113 Kenneth J. Arrow, Economic Welfare and the Allocation of Resources for Invention, in NAT’L BUREAU OF ECON. RESEARCH, THE RATE AND DIRECTION OF INVENTIVE ACTIVITY: ECONOMIC AND SOCIAL FACTORS 609, 615 (1962) (explaining that “[i]n the absence of special legal protection, “[a]ny one purchaser can destroy the monopoly, since he can reproduce the information at little or no cost”); see also WAJSMAN & GARCÍA-VALERO, supra note 31, at 11 (“[R]ivals could free ride on the innovation expenses of the innovators and imitate the new product/process at zero cost.”).

114 See Arrow, supra note 113, at 615 (“With suitable legal measures, information may become an appropriable commodity.”).

115 See Risch, supra note 31, at 3 (discussing how it is more difficult for owners of trade secrets to easily stop others from using them).

116 See Sichelman & Graham, supra note 58, at 129–30 (“[C]ommercial partners may refuse to sign the NDA contract.”).

117 Burstein, supra note 111, at 235 (“[I]nformation is a multilayered, continuous asset that can simultaneously communicate value in different ways.”).

118 See id. at 255 (“More particularly, different types of information about a particular intellectual product may be relevant in different circumstances and contexts of exchange. Information is heterogeneous.”).
tion can be disclosed in seriatim, trade secrets can function much like patents in aiding licensing transactions.\textsuperscript{119}

8. To Provide Strategic Bargaining Leverage

To the extent that trade secrets can enhance the prospects of licensing, they may in turn offer leverage in strategic bargaining with potential partners.\textsuperscript{120} For example, when two companies agree to cross-license their intellectual property and related rights, some of those rights may be covered by trade secrets rather than patents or copyrights.\textsuperscript{121} The ability to protect otherwise unprotected information assets by trade secrets would in theory increase the bargaining power of the trade secret holder in these types of negotiations, because it would lend value to the information—via legal sanctions—that it would otherwise not enjoy.\textsuperscript{122} Indeed, consistent with such a view, one scholar theorizes that knowledge leakage decreases bargaining power and increases new competitors.\textsuperscript{123}

\textbf{B. Reasons for Startups Not to Use Trade Secrecy}

1. Ease of Reverse Engineering and Advantages to Patenting

Because trade secrets can legally be discovered through reverse engineering, they are often difficult to enforce compared to patents.\textsuperscript{124} Although trade secrecy potentially lasts forever, while patents only last about twenty years, if it is relatively easy to discover a secret through reverse engi-

\begin{itemize}
\item \textsuperscript{119} See id. at 235 (discussing how information-flow design overcomes the disclosure paradox).
\item \textsuperscript{120} See generally Castellaneta et al., supra note 33, at 845 (discussing that stronger trade-secrecy protection generates a net increase in the firm market value in industries with higher knowledge-worker mobility); James D. Hamilton & William E. Beaumont, Licensing Patents and Trade Secrets, OBLON (June 2000), http://www.oblon.com/publications/licensing-patents-and-trade-secrets/ (stating that an advantage of trade secret licensing is the ability to leverage business resources).
\item \textsuperscript{121} See Czapracka, supra note 37, at 217 (“[S]ecret know-how concerning the implementation of a patented invention is often licensed with patents, which indicates that there is some level of symbiosis between patents and know-how.”).
\item \textsuperscript{122} See id. (“Trade secrets can be used to protect inventions that are not patentable or those in which the length or other conditions of patent protection are inadequate.”).
\item \textsuperscript{123} See Paavo Ritala et al., Knowledge Sharing, Knowledge Leaking and Relative Innovation Performance: An Empirical Study, 35 TECHNOVATION 22, 24 (2015) (“[Knowledge leakage] decreases bargaining power and even creates new competitors for the original knowledge owner.”); see also Lemley, supra note 31, at 313 (stating that trade secret law was developed to stop knowledge leakage and to prevent new competitors from acquiring their information).
\item \textsuperscript{124} See Trade Secrets, WORLD INTELL. PROP. ORG., http://www.wipo.int/export/sites/www/sme/en/documents/pdf/ip_panorama_4_learning_points.pdf (last visited Aug. 19, 2017) (“A trade secret cannot be protected against being discovered by fair and honest means, such as by independent invention or reverse engineering. . . . A trade secret is difficult to enforce, as the level of protection is considerably weaker than for patents.”).
\end{itemize}
neering, then patents may be preferable. Additionally, “trade secret law protects only against those who procure the information through improper means or who are in specified relationships with a misappropriator,” whereas patents may be enforced against direct infringers, regardless of the infringer’s intention.

To a large degree, the ease with which reverse engineering may be achieved depends on the complexity of the underlying information. For instance, in software, a skilled programmer can often view a product’s functionality and design it. On the other hand, code itself is more difficult, and in some cases impossible, to reverse engineer, making trade secrecy a more attractive option. Thus, in a broader sense, there is often a greater risk to a company of losing “codified technology” than technology that is not yet fully developed. In sum, to the extent that any putative trade secret could be reverse engineered, trade secrecy should be cautiously used.

2. Fear of Others Independently Patenting the Invention

Beyond the fact that independent invention is no defense to patent infringement, patents may become even more attractive because an independent inventor may patent another’s trade secret as long as the inventor has

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125 See, e.g., Bambauer, supra note 64, at 835 (“Patents last for twenty years from the date of filing; secrets (including trade secrets) last as long as sufficient secrecy is maintained.”).

126 Id.

127 See González-Álvarez & Nieto-Antolín, supra note 43, at 291 (“[C]ompanies that use complex knowledge tend to choose cost and time imitation as protection mechanism since the knowledge complexity will increase the time and resources needed to imitate that knowledge.”).

128 See Mann, supra note 70, at 1020 (“[I]t is easy for competitors who observe a new product to design and deploy products that include the functionality of that new product.”); Risch, supra note 6, at 1648 (“[S]oftware might be reverse engineered, which is an acceptable way to discover a trade secret.”).

129 See, e.g., Lemley, supra note 31, at 338–39 (classifying “software source code” as a type of invention “that can be discerned by evaluating the product, but only with difficulty”); Pamela Samuelson & Suzanne Scotchmer, The Law and Economics of Reverse Engineering, 111 YALE L.J. 1575, 1580 (2002) (“When computer programs are distributed in object code form, a difficult analytical process is required to ascertain information embedded in the program, but it is there for the taking if a reverse engineer is willing to spend the time to study it.”).

130 See Mann, supra note 70, at 1020 n.297 (“A firm will be more seriously harmed if it loses codified technology than if it loses technology that it has not yet developed into a specific implementation.”). On the other hand, pharmaceuticals are easy to reverse engineer, so modeling points to patenting, supported by empirical evidence. See Zaby, supra note 35, at 160 (“In an industry sector with a high propensity to patent, such as Pharmaceuticals, the easiness of reverse engineering is rather high . . . .”)

131 See Levine, supra note 44, at 174 (“Additionally, the existence of the right to a perennial secret might make sense in the commercial context where the owner of the secret runs the risk of it being reverse-engineered or independently discovered.”).
developed the same invention by legitimate means.\textsuperscript{132} The fact that a third party may not only escape trade secret infringement via the shield of independent invention, but also acquire a sword to accuse others of patent infringement—perhaps even the original trade secret holder—may often tip the balance in favor of patent protection.\textsuperscript{133}

For instance, Professor Ronald Mann postulates that software startups have no “foothold” protection in trade secrecy given the possibility of independent discovery or invention and subsequent patenting.\textsuperscript{134} Similarly, there is evidence that pharmaceutical and biotech companies decide to patent processes—which otherwise could be maintained as trade secrets—because “if they do not patent the process, they risk that another firm will patent it, and block them from further developing and using it.”\textsuperscript{135} On this view, patents are used not because they are necessarily a superior form of IP protection, but simply because there is “no choice but to patent.”\textsuperscript{136} In this regard, more competition naturally means more risk of being patented out of existence.\textsuperscript{137} Thus, despite the high costs to patenting, the risk of complete or even partial loss may be a powerful incentive to patent.\textsuperscript{138} This is arguably especially the case when a company can withhold some sensitive information about an invention, yet still disclose enough to obtain a patent.\textsuperscript{139}

\textsuperscript{132} See Patents or Trade Secrets?, supra note 6 (“A trade secret may be patented by someone else who developed the relevant information by legitimate means.”).

\textsuperscript{133} See Helmers & Rogers, supra note 42, at 1018 (“Firms may decide to patent even despite secrecy being more effective in protecting an innovation if there is the possibility that a competitor patents a similar innovation first.”).

\textsuperscript{134} See Mann, supra note 70, at 1020 (“[T]rade secrecy does nothing to provide the ‘foothold’ protection that is useful to smaller firms trying to fend off large firm efforts to market competing products. . . . Although patents arguably give small firms some shelter in those contests, trade secret law does not offer the same protection.”).


\textsuperscript{136} Id. (“Today firms typically apply for patents [on the product and process]. . . . This does not mean that they consider patents as enhancing their incentives to create new processes, or even a better means of protection (in fact, patents carry the disadvantage that the information must be published in the patent document), but that they feel they have no choice but to patent.”).

\textsuperscript{137} See Bronwyn H. Hall & Vania Sena, Innovation, IP Choice, and Productivity: Evidence from UK Firms 7 (Dec. 2011) (unpublished manuscript), https://www.bancaditalia.it/pubblicazioni/altriatti-seminari/2012/Hall.pdf (“[F]irms in more competitive sectors . . . tend to use more legal IP methods (i.e. patents and trade marks).”).

\textsuperscript{138} See W. Nicholson Price II, Regulating Secrecy, 91 Wash. L. Rev. 1769, 1782 (2016) (noting that if a firm wants to keep their innovation a secret, patenting their product is not the way to go because there will be some amount of disclosure involved).

\textsuperscript{139} See James J. Anton et al., Policy Implications of Weak Patent Rights, in 6 Nat’l Bureau of Econ. Research Innovation Policy and the Economy 1, 6–7 (Adam B. Jaffe et al. eds., 2006) (noting three types of secrecy effectiveness in patents one of which is the naked idea invention where some element of private information exists).
3. Inability to Market or Even Explain to Investors

A major challenge with utilizing trade secrecy (in the legal sense) is having to utilize secrecy (in the general sense). Trade secrecy typically does not attract venture capitalists and other investors who may refuse to sign confidentiality agreements. Patents, on the other hand, are typically more well-defined sets of rights that can provide something “tangible” for startups to sell to potential investors.

Patents may allow for better signaling to investors, and thus may be more valuable to inexperienced innovators. Or it may simply be the case that a company is willing to disclose otherwise secret information to raise investment dollars regardless of whether it can patent or gain other IP protection. In contrast, beyond startup financing, trade secrecy may make it more difficult for analysts and institutional investors to follow companies that

140 See, e.g., Bambauer, supra note 64, at 840–41, 844–45 (noting the difficulty in keeping trade secrets a secret and the various ways trade secrets can be revealed).

141 See Png, supra note 13, at 27 (“[T]rade secrets might not help to attract venture capitalists.”). Startups need patents to market. See Graham et al., supra note 7, at 1288 (“[A] partial explanation for the widespread use of patents by technology entrepreneurs[ ] concerns the function that patents serve in helping the startup compete in the marketplace with its innovative technology.”); Andrew A. Schwartz, The Corporate Preference for Trade Secret, 74 Ohio St. L.J. 623, 667 (2013) (drawing on empirical research to argue that startups should use patents because of venture capital needs). To that end, interest in international markets makes patents more useful than informal methods if looking to international markets. See Peter Neuhausler, The Use of Patents and Informal Appropriation Mechanisms—Differences Between Sectors and Among Companies, 32 Technovation 681, 684 (2012) (“Patents especially play an important role in the ability of firms to enter foreign markets. Besides market entry, formal instruments, e.g. patents, could provide firms an edge on international markets.”). But see Lippoldt & Schultz, supra note 38, at 9 (“The availability of trade secrets protection may also play a role in international diffusion of technologies and other information via foreign direct investment (FDI) or trade.”).

142 See Richard C. Levin et al., Appropriating the Returns from Industrial Research and Development, 3 Brookings Papers on Econ. Activity 783, 831 (1987) (“Patents may be much more important for a start-up company because they provide something tangible to sell if the firm tries to sell out later.”).

143 See Annamaria Conti et al., Patents As Signals for Startup Financing 4, 14 (Nat’l Bureau of Econ. Research, Working Paper No. 19191, 2013) (“[P]atents [act] as a signal of technology quality to investors . . . .” “[T]he founders of a startup strategically use patents to convey information about the value of their inventions, given that external investors judge the quality of these inventions based on the patents they observe.”); David H. Hsu & Rosemarie H. Ziedonis, Patents as Quality Signals for Entrepreneurial Ventures 12 (2007) (unpublished draft) (“Early stages of funding are characterized by greater technical and demand uncertainty in product development. In such settings, start-up quality signals such as patents are particularly important . . . .”).

are publicly traded. To the extent that a startup’s strategy is to do an initial public offering (IPO), a business strategy centered around trade secrecy may not be the most sensible.

4. Tension with Open Source, Open Innovation, and Other “Sharing” Models

The growth of open innovation, open source, and other business models that require significant sharing of information between companies and individuals could deter use of trade secrecy and other intellectual property doctrines. Specifically, close cooperative relationships and joint projects often render it difficult to maintain trade secrets, so first-mover advantage or patents may become the best appropriation option.

For example, computer chip designer Open-Silicon claims to successfully use an open business model “that enables the company to uniquely choose best-in-industry [Internet Protocol], design methodologies, tools, software, packaging, manufacturing and test capabilities,” resulting in part-


146 See id. at 4 (“[S]tronger trade secret protection lowers analyst forecast quality in terms of dispersion and accuracy.”).

147 See Henry Chesbrough, Open Business Models: How to Thrive in the New Innovation Landscape 2 (2006) (describing how the growing division of innovation labor opens up a company’s business model and allows them to acquire more ideas); Henry W. Chesbrough, Open Innovation: The New Imperative for Creating and Profiting from Technology 43 (2003) (“Open Innovation means that valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well.”); Yochai Benkler, From Consumers to Users: Shifting the Deeper Structures of Regulation Toward Sustainable Commons and User Access, 52 FED. COMM. L.J. 561, 577 (2000) (“A robust public domain in existing information” “requires self-conscious policy choices to support the development of free software and open source strategies for software development.”);

148 See Leiponen & Byma, supra note 59, at 1486 (“[I]nnovative small firms that have close cooperative arrangements may be at a disadvantage in protecting their innovation returns.” “Secrecy is difficult to maintain in joint projects . . . . Thus, the only recourse is to appropriate returns to innovation by quick market launch.”).
nnerships with “over 150 companies.” Similarly, “Free and Open Source hardware,” also known as “Libre Hardware,” “is gaining significant traction in the scientific hardware community, where there is evidence that open development creates both technically superior and far less expensive scientific equipment than proprietary models.” Thus, trade secrets may stand in the way of a startup’s newer business model or strategy, as well as the benefits of information diffusion to consumers, industry, and society as a whole.

5. Reliance on Contracts Like Covenants Not to Compete and Nondisclosure Agreements

Some scholars have argued that contracts can, or least should, do all that trade secrecy can do. Although this view is debatable, often noncompete and nondisclosure agreements can effectively substitute for trade secrecy protection, at least for those bound by these agreements. Technically, contracting with employees does not preclude use of trade secrets as a complementary form of protection. In this sense, contract and trade

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150 Joshua M. Pearce, Emerging Business Models for Open Source Hardware, 1 J. OPEN HARDWARE 1, 1 (2017) (comparing such models to “[c]onventional business models” that achieve monopoly “by either protecting the . . . related to the product as a trade secret or with a patent”).

151 See, e.g., Levine, supra note 44, at 165 (“The vastly divergent roles and responsibilities of government, like transparency and accountability, versus industry’s premium on secrecy, profit-making, and competition, make the application of trade secrecy to public institutions—or private entities operating in the public sphere—troubling.”).

152 See Bone, supra note 23, at 297 ("[W]ith perhaps a few limited exceptions, trade secrets should be protected only on contract principles."); James W. Hill, Trade Secrets, Unjust Enrichment, and the Classification of Obligations, 4 VA. J.L. & TECH. 2, ¶ 44 (1999) ("Professor Bone believes that ‘trade secret law is not essential to the protection of intellec
tual property; in fact, most of its benefits are better achieved through contract . . . .’" (quoting Bone, supra note 23, at 246–47)); Alan J. Tracey, The Contract in the Trade Secret Ballroom—A Forgotten Dance Partner?, 16 TEX. INT’L PROP. L.J. 47, 66 (2007) (“In some cases, the contract is thought to serve the dual function of satisfying trade secret requirements . . . .

153 See Sampsa Samila & Olav Sorenson, Noncompete Covenants: Incentives to Innovate or Impediments to Growth, 57 MGMT. SCi. 425, 427 (2011) ("Even when companies have alternative mechanisms for protecting their intellectual property, the enforcement of noncompete covenants might still strengthen these protections."); id. at 432 ("But patenting might also increase even in the absence of greater innovation if firms attempt to substitute patents for the intellectual property protection offered by noncompete covenants. . . . [F]irms, on average, invest less in R&D under regimes of strong noncompete enforcement; thus one would expect them to produce fewer innovations.").

secrecy are not always substitutes. Indeed, noncompete agreements can bolster baseline trade secret protection, making it even more difficult for an employee to depart for a competitor. On the other hand, the fear of an employee running off with the startup’s crown jewels may easily lead the firm to patent, which may preclude at least some trade secret protection.

II. THE PAUCITY OF EMPIRICAL STUDIES ON TRADE SECRECY

Although trade secret theory is certainly far from a finished product, empirical studies of trade secrets are still in their infancy, and other than the few articles reporting on the Berkeley Patent Survey, there are no reported studies focusing on the use of trade secrets by startups. This “gap in the [empirical] literature” on “alternatives to the patent system for appropriating innovative results” like “industrial secret[s]” clearly supports the need for more empirical work. Indeed, in perhaps the most comprehensive survey of empirical studies on trade secrecy to date, Professor Michael Risch opines

155 See Hill, supra note 152, ¶ 96 (arguing that the rationales and values inherent in trade secret law cannot be protected through contract law alone); Lemley, supra note 31, at 331–32 (“Trade secret law also reaches where contract alone cannot. . . . [I]t extends the reach of the law beyond privity of contract to anyone who comes into contact with a secret knowing that they have acquired it by accident, mistake, or by another’s malfeasance.”).

156 See PepsiCo, Inc. v. Redmond, 54 F.3d 1262, 1272 (7th Cir. 1995) (affirming an injunction barring an employee from taking on a position at a competitor company because his reliance on PepsiCo’s information was inevitable); Carey DeWitt, Trade Secret Law for the Employment Lawyer: Handling a Misappropriation Case, Mich. B.J., Jan. 2005, at 20, 22–23 (explaining that “trade secret law is often connected with enforcement of non-compete [agreements]” and “[s]uch agreements are legitimately designed to prevent post-employment unfair competition by the departing employee”); see also Wajcman & García-Valero, supra note 31, at 15 (noting that explicit nondisclosure and noncompete clauses in employee contracts may inhibit employee mobility). The controversial “inevitable disclosure doctrine” could also serve the same purpose, as it allows employers to control former employee behavior without proving actual damage. Shannon Aaron, Note, Using the History of Noncompetition Agreements to Guide the Future of the Inevitable Disclosure Doctrine, 17 Lewis & Clark L. Rev. 1191, 1191 (2013) (“Some states have expressly rejected the doctrine while other states have openly accepted it.”).

157 See Gallié & Legros, supra note 107, at 782–83 (“Analysing the link between human resources practices and the choice between patenting and trade secrecy . . . the introduction of strategies to secure employee loyalty (in other words, to reduce job mobility) leads to greater use of trade secrets than patents. Firms with a high turnover of engineers prefer the patenting strategy to limit the risks of information being disseminated.”).

158 See supra Introduction.

that “the reality is that we know very little about trade secrets, despite the best efforts of a handful of scholars conducting research in this area.”

Of course, there is a good reason for the dearth of literature: “[C]ompanies’ use of [trade] secrecy is “unobserv[able].” Nonetheless, there have been a few broad empirical studies, though many of the leading studies in the field are dated. For instance, Professor Bronwyn Hall recently reviewed the existing trade secret empirical literature and noted that the “seminal studies” in the field remain the Levin et al. study from 1987 and the Cohen et al. study from 2000.

While the major studies in the field may be dated, the trend is toward more scholarly focus on trade secrecy, particularly with the adoption of the European Union (EU) Trade Secret Directive and the Defend Trade

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162 See Petra Moser, *Innovation Without Patents: Evidence from World’s Fairs*, 55 J.L. & ECON. 43, 44 (2012) (“A lack of systematic economywide data, however, has made it impossible to measure the share of innovations that occur outside the patent system.”). Despite the reality of limited empirical data, there is also limited historical analysis of trade secret use. See Risch, *supra* note 31, at 5 (noting that because trade secrets are so different from patents and copyrights, trade secret history does not provide a normative basis for the law).


164 See Levin et al., *supra* note 142, at 785, 787 (examining “appropriability conditions in more than one hundred manufacturing industries” and finding that “more appropriability is better, that better protection necessarily leads to more innovation, which yields better economic performance”).

165 See Wesley M. Cohen et al., *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)* 1 (Nat’l Bureau Econ. Research, Working Paper No. 7552, 2000) (“[F]irms typically protect the profits due to invention with a range of mechanisms . . . . [P]atents tend to be the least emphasized [mechanism] by firms in the majority of manufacturing industries, and secrecy and lead time tend to be emphasized most heavily.”). Almeling has conducted recent empirical studies of trade secret litigation at the state and federal levels, but these do not focus on trade secrecy at the firm level. See David S. Almeling et al., *A Statistical Analysis of Trade Secret Litigation in State Courts*, 46 GONZ. L. REV. 57, 69 (2010) (noting that 93% of trade secret state cases involved an employee or a business partner); Almeling et al., *supra* note 161, at 294 (noting that 85% of trade secret federal cases involved an employee or a business partner).

Secrets Act (DTSA) in the United States.\textsuperscript{167} Specifically, the EU Trade Secret Directive, adopted on June 8, 2016,\textsuperscript{168} “aims to standardise the national laws in EU countries against the unlawful acquisition, disclosure and use of trade secrets.”\textsuperscript{169} The DTSA, which became law in May 2016 and represents the biggest development in U.S. intellectual property law in years, provides a broad federal private cause of action for trade secret misappropriation.\textsuperscript{170}

Here, we focus on the trade secret empirical literature as it applies to startups. As an initial matter, it is important to note that startups are often conflated with small businesses (in Europe, often termed “small and medium-sized entities” (SMEs)).\textsuperscript{171} While it is generally true that startups tend to be SMEs, it is not the case that SMEs must be startups. As one commentator noted, “not all SMEs are equal. . . . [S]tart-ups tend to be a group of their own and not surprisingly may have appropriability strategies that are different from established small firms.”\textsuperscript{172}

Although there have been a number of studies on SMEs, other than the limited data released to date from the Berkeley Patent Survey, there is nothing in the trade secrecy empirical literature focusing on startups as a separate category.\textsuperscript{173} The result is that most views of how startups use trade secrecy are based on anecdote and speculation. For example, the seminal Levin et al. study notes that “start-up ventures” were “completely excluded” from the study, but Levin speculates that patents—implicitly, in contrast to trade


\textsuperscript{169} \textit{Eur. Comm’n, Trade Secrets}, supra note 166.

\textsuperscript{170} See Sharon K. Sandeen & Christopher B. Seaman, Toward a Federal Jurisprudence of Trade Secret Law, 32 Berkeley Tech. L.J. 829, 833 (2017) (“The May 11, 2016 enactment of the DTSA created a federal civil cause of action for trade secret misappropriation for the first time.”); \textit{see also} Levine & Seaman, supra note 3, at 108 (noting the increasing profile of trade secret litigation, and that nearly 500 federal cases were filed under the DTSA in its first year).

\textsuperscript{171} See Hall et al., unpublished draft, supra note 8, at 405 (indicating that small and medium-sized enterprises are also called SMEs and associating startups with SMEs).

\textsuperscript{172} \textit{Id.} at 405–06 (noting that startups, which are known as being an SME, have a different strategy than many other SMEs.) For example, like large companies, patents can be important to startups while detrimental to other SMEs. \textit{Id.}

\textsuperscript{173} As noted earlier, the few articles from the Berkeley Patent Survey reporting on trade secrecy were quite limited, describing only general results related to the relative importance of patenting and trade secrecy as well as to the reasons not to patent. \textit{See Graham et al., supra note 7, at 1290–93, 1295–96; Sichelman & Graham, supra note 58, at 173.
secrets—may be more important for a startup than for more established companies because “they provide something tangible to sell if the firm tries to sell out later.”174

In the following discussion of existing studies, we follow a similar “speculative” strategy. First, although SMEs are not synonymous with startups, they often overlap, so we begin by reporting on SME-focused studies.175 Next, we broaden our discussion to more general studies, speculating on how those findings relate to startups.176

A. Previous Empirical Studies of SMEs and Trade Secrecy

In these studies, SMEs tend to favor trade secrecy over patents.177 The most common reason SMEs prefer trade secrecy is the cost of obtaining and enforcing patents.178 For example, a survey of 2849 R&D performing firms

174 Levin et al., supra note 142, at 831. Theoretical papers discuss startups a bit more frequently. See, e.g., Andreas Panagopoulos & In-Uck Park, Patenting vs. Secrecy for Startups and the Trade of Patents as Negotiating Assets 13 (Univ. of Crete, Dep’t of Econ., Working Paper No. 1610, 2015), http://economics.soc.uoc.gr/wpa/docs/1610.pdf (concluding that patents are better than trade secrets for incentivizing startups); Ivan Png, Trade Secrets, Non-Competes, and Inventor Mobility: Empirical Evidence, 14–15 (June 2012) (unpublished manuscript), https://conference.druid.dk/acc_papers/dthe9spk32t5q331r0hck9duo6.pdf (constraints on using knowledge because of trade secrets and CNCs leads to fewer spin-outs and startups, based on a study of employed investors with utility patents from the U.S. Patent Inventor Database).

175 See infra Section II.A.

176 See infra Section II.B.

177 See EUR. COMM’N, Study on Trade Secrets, supra note 41, at 2 (“The higher perceived cost of patent ownership and the material impact that disclosure may have on SME firm value and performance encourage use of secrecy as a protection mechanism.”); Arundel, supra note 32, at 614 (“The results show that firms of all sizes find secrecy to be relatively more important than patents, but small firms find secrecy to be of greater importance than larger firms.”); Gallié & Legros, supra note 107, at 782 (noting that small and medium-sized firms prefer secrecy and that patent propensity rates tend to increase with firm size); Leiponen & Byma, supra note 59, at 1479 (conducting a literature review and concluding that patents are less “efficient”). But cf. Mann, supra note 70, at 966, 1021 (conducting a survey of sixty people knowledgeable about SME software companies and finding trade secrets were not particularly helpful).

178 See EUR. COMM’N, Study on Trade Secrets, supra note 41, at 103–04 (“Based on a survey among 198 small US firms operating in high technology sectors” “two main reasons why small, high-technology firms may choose secrecy over patents are the costs involved in enforcing patent rights and the requirement to disclose the innovation as part of the patent application.”); id. at 108 (“Concerns over patent enforcement costs and disclosure requirements are important reasons why SMEs prefer trade secret compared to patent protection.”). Kitching’s study of 400 British SMEs indicated that the cost of maintaining patents was “prohibitively high,” so those entities would rather allocate limited resources to “new product and process innovations.” See John Kitching & Robert Blackburn, Intellectual Property Management in the Small and Medium Enterprise (SME), 5 J. SMALL BUS. & ENTERPRISE Dev. 327, 331, 333 (1998) (“The money costs of filing, maintaining and defending a patent are often perceived by business owners as prohibitively high.” “Instead of acquiring and enforcing formal intellectual property rights to protect existing products, SME owners pre-
found that secrecy is more important than patents, and small firms find secrecy more important than large firms.\textsuperscript{179} Surveys of eight Finnish SMEs, including IT firms, found that secrecy was the most popular appropriation method, ahead of IP and contracts.\textsuperscript{180} Another survey of small Finnish firms found 62\% using secrecy (the third highest total in the survey; speed to market was slightly higher) versus 16\% using patents (lowest of all surveyed options).\textsuperscript{181} Naturally, these surveys also confirm the corollary that large firms benefit more from patents.\textsuperscript{182} There is also little reported variance between process- and product-focused firms.\textsuperscript{183}

It is notable that, in at least one study, the risk of departing employees misappropriating trade secrets did not appear to justify using patents instead of trade secrecy and other mechanisms. Specifically, a study of 400 SME owner-managers in British computer software, design, electronics, and mechanical engineering firms found that 71\% of their “products, services or methods of working were dependent [ ]on specialist or confidential knowledge,” and the biggest threat of loss was departing employees.\textsuperscript{184} The most common response (79\%) was not to resort to patents as a means of protecting against leakage,\textsuperscript{185} but rather to build “[t]rust relationships that ensure specialist knowledge is not stolen,”\textsuperscript{186} which is at the heart of “reasonable efforts” in trade secrecy.\textsuperscript{187} Even though patents are generally viewed as a more powerful right than trade secret protection, this result suggests that the
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costs of patenting are often greater than the risk of departing employees, particularly when that risk can be mitigated through firm culture and personal relationships.\(^{188}\) Of course, in many situations, specialized and confidential knowledge may be protectable as a trade secret but may not be inventive enough—or may be of such a nature—as not to be patentable.\(^{189}\) Thus, even for firms that can afford patent protection, trade secrecy—with its more expansive set of protectable subject matter—may be the only option available.\(^{190}\)

B. Speculating on the Results of More General Studies

In view of the limited empirical research even indirectly addressing startups and trade secrecy, there are some broad themes that emerge from the more general trade secret empirical research that may help discern how and why startups use trade secrets (or not). Here, we analyze those studies to form hypotheses regarding startups that we then test via our study.

1. The Benefits of “Informal” vs. “Formal” IP

Trade secrecy is usually categorized as an “informal” method of appropriation. For example, it is common to define “formal” IP as including patents, trademarks, copyright, and registered designs, and “informal” IP as including “secrecy, confidentiality agreements, lead time, or complexity.”\(^{191}\) The meaning of this distinction is not entirely clear, especially as trade secrecy has similar attributes to formal IP in that it is statutorily-based and operates as an “ex ante incentive[ ] to innovate.”\(^{192}\) Moreover, “unregistered trust, confidence and loyalty” that obligates employees to use and to refrain from using trade secrets in certain ways).

188 Galliè & Legros, supra note 107, at 782–83 (“Analysing the link between human resource practices and the choice between patenting and secrecy . . . the introduction of strategies to secure employee loyalty (in other words, to reduce job mobility) leads to greater use of trade secrets than patents.”); Patents or Trade Secrets?, supra note 6 (“A trade secret is more difficult to enforce than a patent. The level of protection granted to trade secrets . . . is generally considered weak, particularly when compared with the protection granted by a patent.”).

189 See Nisvan Erkal, On the Interaction Between Patent and Trade Secret Policy 1, 10 (Oct. 2004) (unpublished manuscript), http://www.nisvanerkal.net/patent-trade-secrecy-final.pdf (noting that there are innovations that are entitled to trade secret protection but they are not developed enough to qualify for patent protection).

190 See JENNIFER B RANT & SEBASTIAN L OHSE, INT’L CHAMBER OF COMMERCE, TRADE SECRETS: TOOLS FOR INNOVATION AND COLLABORATION 10 (2014) (noting that it would be advantageous for enterprises to rely on trade secrets over patents); see also Levine, supra note 44, at 150, 154 (noting that almost any valuable information can be held as a trade secret).

191 Hall et al., The Choice Between, supra note 8, at 376.

192 Id. (“[Trade secrets] provid[e] a reward system that makes it easier for innovators to make ex post profits if their innovation is successful by allowing them to exclude imitators for a finite period.”). Although the origins of trade secrecy lie in the common law, at least in the United States, most of trade secret law is now based in statute, such as the Uniform
formal IP” and informal IP share the problem that they are “by construction, largely unobservable or only partially observable to third parties, which creates a formidable challenge for empirical work.”

It is conceivable that “secrecy,” as a general business practice, could be construed as informal IP whereas the use of “trade secrecy,” as a legal doctrine, would be viewed as formal. Whatever the proper characterization of trade secret rights, it is worth noting that several existing studies show that informal IP is often a stronger or more preferred appropriation method than formal IP, particularly with regard to patents, and remains on the rise generally (even past the seminal Cohen study). Although these studies find that small firms often prefer informal IP, given startups’ reliance on patents for financing, it is less clear whether the ease and low costs of trade secrets necessarily trump the use of patents in the startup setting.

2. Products vs. Processes

The literature also draws a meaningful distinction between innovative processes and innovative products. Generally, studies have shown that secrecy and lead-time are more important means than patents when protecting process innovations against duplication and competition. Processes are usually harder to detect, and therefore are more apt for trade secret protection; conversely, it can often be difficult to use trade secrecy to shield a
product that can be easily accessed and examined.\(^{199}\) In this regard, the European Commission’s survey of existing trade secret empirical studies concluded that process innovations are widely protected by trade secrecy.\(^{200}\) Thus, one would expect to find that startups value trade secrecy more for processes than products.

3. Lead-Time and First-Mover Advantage

Maintaining lead time (also known as “first mover advantage”) is often cited as a primary reason to use trade secrecy.\(^{201}\) Indeed, the common “lead time injunction” is designed to bar “use of a trade secret for a limited period of time adequate to prevent the defendant from gaining a competitive advantage through use of the stolen trade secret.”\(^{202}\) For example, in a study of 8000 British and American innovations at world fairs between 1851 and 1915, secrecy was “often used as a complement to other mechanisms such as lead time (being the first to introduce a new product to the market) and the provision of unique complementary assets.”\(^{203}\) Another study found that “both patents and [trade secrets] can be strategically used to create market lead times.”\(^{204}\) Similarly, a study of “small and innovative Finnish manufacturing and service firms” found that “speed to market” was slightly more preferred than secrecy and much more preferred than patents.\(^{205}\) In this regard, studies—such as the European Commission’s (EC)—find that the most important reason to use trade secrecy is not wanting to disclose information, which presumably results in losing lead-time advantage.\(^{206}\)

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199 See Arundel, supra note 32, at 613 (“The survey results for process innovations can be explained by the ability of firms to keep process innovations hidden from their competitors for long periods of time.”); Cohen et al., supra note 165, at 10; Hall et al., The Choice Between, supra note 8, at 380 (reviewing literature); Katrin Hussinger, Is Silence Golden? Patents Versus Secrecy at the Firm Level, 15 Econ. Innovation & New Tech. 735, 751 (2006) (noting that firms likely use trade secrecy for process innovations, “which is not captured by sales figures with new products”).

200 See EUR. COMM’N, Study on Trade Secrets, supra note 41, at 97–100.

201 See Arundel, supra note 32, at 615 fig.1 (surveying 2849 R&D performing firms and finding that lead-time is far more important than secrecy and patents); Hurmelinna-Laukkanen & Punamalainen, supra note 35, at 106 (finding a positive relationship between seeking short-term value and the use of lead-time and noting that IPR, which was defined as separate from “secrecy,” was not “used for this purpose”). This result, assuming the accuracy of the dichotomy, might make sense for startups as well, given lead-time’s overlap with trade secrecy. Indeed, Graham suggests that lead-time efforts will limit use of secrecy. See Graham, supra note 159, at 10.


203 Moser, supra note 162, at 46 n.5.

204 Holgersson, supra note 88, at 25.

205 Leiponen & Byma, supra note 59, at 1478, 1486.

206 See, e.g., EUR. COMM’N, Study on Trade Secrets, supra note 41, at 124 (“The most important reason why businesses rely on [trade secrets] rather than on other IPRs concerns the need to not disclose information . . . .”).
The implications from these results for startups, however, are not entirely clear. Although trade secrecy can be used to achieve lead-time advantages, there are other means—such as continuous advancements over competitors—that may be equally effective.\(^{207}\) Indeed, several studies have shown that less important innovations skew toward patenting, while more important innovations skew toward trade secrecy, all other factors being equal.\(^{208}\)

4. Industry Analysis: Software and Biotechnology

A number of studies have made major efforts to analyze trade secrecy in the context of specific industries. However, in its review of existing empirical studies, the EC study noted an important limitation: with one exception, “[a] drawback of these studies . . . is that they focus exclusively on manufacturing industries and do not evaluate empirically the importance of trade secrets in a non-manufacturing setting.”\(^{209}\)

The two leading studies, Levin et al. and Cohen et al., generally found that a range of industries prefer trade secrecy, whether for products or processes.\(^{210}\) To the extent that there are any consistent findings, the chemical industry tends to value trade secrecy more than others.\(^{211}\) On the other end, industries that produce innovations that can be easily copied or duplicated naturally tend to find trade secrecy less desirable.\(^{212}\)

A study of French firms found that “technology-push” industries—namely, those where the technology itself (rather than market preferences

\(^{207}\) See, e.g., González-Álvarez & Nieto-Antolín, supra note 43, at 288–89 (in a study of 258 Spanish manufacturing companies, “[c]ontinuous innovation that enables companies to keep their competitors behind is the mechanism most commonly used,” ahead of trade secrets and patents).

\(^{208}\) See Gallié & Legros, supra note 107, at 786; Helmers & Rogers, supra note 42, at 1018; Pajak, supra note 42, at 10.

\(^{209}\) EUR. COMM’N, Study on Trade Secrets, supra note 41, at 97.

\(^{210}\) See id. at 97–100 (referencing Cohen’s study of 1478 manufacturing R&D labs, which found trade secrets generally very important).

\(^{211}\) Sector analysis shows chemical industry and a few others consistently preferring trade secrets. See Pajak, supra note 42, at 10 (noting that in the chemical industry, secrecy is more commonly used than patents); see also Cohen et al., supra note 165, at 33 tbl.2 (secrecy used most by textile, paper, chemicals, rubber, plastics, drugs, and metal); Leiponen & Byma, supra note 59, at 1483 tbl.4; Moser, supra note 162, at 58, 64, 65 tbl.9 (noting that chemicals, mining and metallurgy, textiles, and food processing had the lowest patent rates of innovations displayed at world fairs from 1851 to 1915, even while the rates increased over time, because these were the most difficult innovations to copy). But cf. González-Álvarez & Nieto-Antolín, supra note 43, at 290 tbl.4 (concluding Spanish chemical manufacturing firms use patents and secrecy almost equally).

\(^{212}\) See, e.g., Cohen et al., supra note 165, at 33 tbl.2 (publishing industry consistently least interested in trade secrecy); Leiponen & Byma, supra note 59, at 1483 tbl.4 (trade secrecy is not desired at all by transport equipment, furniture, recycling, electricity, and wholesale trade industry groups); Moser, supra note 162, at 69 (manufacturing machinery was easier to copy, so that industry witnessed more patents than others, such as the chemical industry).
per se) is the primary driver of innovation, such as the software industry—value secrecy (along with complexity and lead-time advantage) as important appropriation methods.213 In this regard, Professor Michael Mattioli, in his study of big data practices, notes that source code is a prime candidate for trade secret protection.214 Indeed, David Almeling’s extensive trade secret litigation studies confirm that software trade secrets are heavily litigated.215 Importantly, none of the aforementioned studies focused on startups. Nonetheless, one would expect that for similar reasons, software startups are likely to rely heavily on trade secrecy.

Unfortunately, other than the limited data released to date from the Berkeley Study, there is very little empirical data on the use of trade secrecy in the biotechnology sector. There has been some investigation of the role trade secrets play in alliances between firms in the biotechnology industries. Specifically, several studies have found that relatively strong reliance on trade secrets can better promote alliances between biotechnology and pharmaceutical companies.216

5. Collaboration

As just noted, trade secrets may play a role in fostering collaboration in certain industries. Some studies have investigated across industries whether collaborative entities prefer trade secrets to patents as a means of protecting against misappropriation. In this regard, departing employees are often viewed as the biggest threat.217 After all, by far the most common trade secret litigation involves the departing employee who runs off with trade secrets to a competitor or to form a new company.218 Yet, it may not be

213 See Gallié & Legros, supra note 107, at 789 tbl.A.1 (defining “technology push” markets as firms where “innovation has been determined by the dynamics of the technology itself”).
214 Mattioli notes that “information-based processes” (i.e., big data algorithms) are well suited for trade secret protection. Michael Mattioli, Disclosing Big Data, 99 MINN. L. REV. 553, 550–51 (2014). In addition, Hurmelinna-Laukkanen & Puumalainen speculate that secrecy should have a significant role in knowledge-intensive fields such as software. See Hurmelinna-Laukkanen & Puumalainen, supra note 33, at 107; see also González-Álvarez & Nieto-Antolín, supra note 43, at 285 (noting that “technology” companies tend to choose “industrial secret”).
215 See Almeling et al., supra note 165, at 60 (indicating that software and technical knowledge remain heavily litigated). Technical trade secrets, like software or computer programs, are heavily litigated in state courts, although internal business trade secrets, such as internal business information and customers lists, are more heavily litigated. Id.
218 See Almeling et al., supra note 161, at 294 (noting that the most common alleged trade secret misappropriators are employees and business partners).
surprising that entities that engage in collaborative efforts might prefer patents, because they protect against misappropriation without proof of an improper act.\(^{219}\) Indeed, Henry Hertzfeld found in a study of United States–based firms that collaborative entities preferred patents.\(^{220}\)

On the other hand, one might reasonably conclude that trust in the firm’s ability to control information leakage allows trade secrecy to be more effective. Entities that focus on “[t]acit knowledge,” which generally refers to “undefined [knowledge]. . . incorporated [in] to the firm’s organisational routines,”\(^{221}\) might be more comfortable using trade secrecy because of the difficulty of copying such information, especially when employees are generally loyal.\(^{222}\) Finally, to the extent firms can apply for patents without always disclosing the “secret sauce” of their inventions, it is possible that both patents and trade secrecy could be used to prevent misappropriation and thus foster collaboration.\(^{223}\) Which approach collaborative startups prefer—patents, trade secrets, or a complementary blend of patents and trade secrets—is thus not entirely clear, and thus is of great interest.

6. Knowledge Spillovers

Even for firms that do not collaborate, there is often fear of knowledge leakage, which from an economist’s perspective is often viewed as beneficial knowledge spillovers.\(^{224}\) Exactly how well trade secret protection performs this function is uncertain based on existing studies. One study of 3900 German industry and service firms found that firms consider patents and secrets equally important to prevent knowledge spillovers.\(^{225}\) Analyzing the impact of the passage of the Uniform Trade Secrets Act (UTSA) on knowledge spillovers across the United States, Png concluded that “the UTSA, by reducing spillovers, lowered the expected return from R&D, and so, led to less R&D.”\(^{226}\) Indeed, in their comprehensive study of existing empirical

\(^{219}\) See Arundel, supra note 32, at 622.


\(^{221}\) Galende, supra note 159, at 110.


\(^{224}\) See Tobias Schmidt, An Empirical Analysis of the Effects of Patents and Secrecy on Knowledge Spillovers 3 (Ctr. for European Econ. Research, Discussion Paper No. 06-048, 2006), ftp://ftp.zew.de/pub/zew-docs/dp/dp06048.pdf (noting that firms would not “have an incentive to invest in the development of new knowledge if all the benefits would spill over to their competitors”).

\(^{225}\) See id. at 10–11, 19.

\(^{226}\) See Png, supra note 13, at 3. Kultti, Takalo, and Toikka made a related observation based upon theoretical modeling, noting that “the patent system can simultaneously increase the spillovers and enhance the incentive to invest in R&D.” Kultti et al., supra note 35, at 37.
research regarding the impact of covenants not to compete on knowledge spillovers, Professors Jonathan Barnett and Ted Sichelman—while rejecting the view that noncompetes necessarily diminish innovation—accepted the notion that limiting noncompete enforcement increases "the circulation of R&D personnel."227 As enforcement of trade secret law, by definition, leads to less movement of information and personnel, a general theory prevails that knowledge spillovers—all other factors equal—decrease with the utilization of trade secrecy as an appropriability mechanism.228

7. Research and Development (R&D)

Conflicting data exists regarding how trade secrecy affects the decisions of firms to engage in R&D. For example, Professor Aija Leiponen found that heavy R&D industries rely more on patents and first-mover advantage than secrecy.229 Consistent with this finding, another study found that trade secret protection leads to less R&D among low-tech companies,230 and specifically that the emergence of the statutory UTSA leads to a small reduction in R&D.231

On the other hand, one study found that R&D intensive firms in Germany preferred trade secrecy to other appropriation mechanisms, such as patents and lead time.232 Another European study similarly found that innovative French firms with large R&D budgets prefer secrecy.233 Although these results could potentially be explained by the fact that patents are generally perceived to be weaker in Europe than other regions, such as the United States, the results are certainly in tension with those studies, finding that minor innovative leaps wind up being protected more by trade secrecy and major leaps more by patents.234

As Png aptly remarked, “[a]pparently, the impact of trade secrets law on . . . innovation continues to be an open issue.”235 Given the uncertain effect of trade secrets on R&D, it is difficult to predict how trade secrets affect startup R&D, especially relative to other appropriation mechanisms.

227 See Barnett & Sichelman, supra note 104, at 5.
228 Of course, to the extent that trade secrecy promotes the production of knowledge, weak trade secret law could result in so little knowledge that overall spillovers also decreased. See id.
229 See Leiponen & Byma, supra note 59, at 1483.
231 See Png, supra note 13, at 19.
232 See Wademan & Garcia-Valero, supra note 31, at 8 (finding that German firms’ “use of trade secrets for protecting innovations is higher than the use of patents”).
233 See Gallié & Legros, supra note 107, at 785, 787.
234 See supra note 69 and accompanying text.
235 Png, supra note 13, at 6.
8. Hybrid Strategies

As we discussed earlier, trade secrets are not always a mutually exclusive option for protecting intellectual assets. Yet, there is surprisingly little empirical study on the broader question of whether firms engage in hybrid strategies, like complementary patent-trade secret protection, much less what are the determinants of hybrid strategies. As Png notes, most analytical studies treat trade secrets and patents as substitutes. He explains the basic assumed structure as “first, the innovator decides on R&D, then, the innovator chooses between patents and secrecy, and finally, the innovator engages with possible competitors.”

In this regard, empirical evidence shows that patents are not an effective tool in any industries, and especially not taken alone. As explained by Hall and her coauthors: “[C]ompanies appear to use a combination of different appropriation mechanisms even for the same invention . . . . If patent protection is not available, there is still innovation, albeit innovation that can be more easily protected by informal mechanisms including secrecy.”

A study of 250 large, diversified U.S. companies involved in research partnerships is a good example of this trend. Specifically, this study found that trade secrets were used to protect know-how and tacit knowledge, especially in the “early, negotiating stage of a partnership,” but patents were still ahead of trade secrecy to protect “existing technology (background knowledge).”

Nonetheless, the result of little empirical data is a fair amount of theorizing and educated guessing, although not focused on startups. Thus, Hall and her coauthors have suggested that researchers should take a closer look at patents and trade secrets as complements rather than substitutes. Indeed, many of the studies that discuss secrecy do so as an afterthought and

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236 See supra Part I (discussing utilizing trade secrecy to extend a lead-time advantage, patenting a trade secret, utilizing covenants alongside with trade secrets).
237 See Graham, supra note 159, at 6–8; Hall et al., supra note 8, at 411.
238 See Simon & Sichelman, supra note 34, at 377.
239 Png, supra note 230, at 5. González-Álvarez & Nieto-Antolín note that high technology may be a hybrid situation where trade secrecy is used during early R&D followed by patent once developed. See González-Álvarez & Nieto-Antolín, supra note 43, at 284; see also Simon & Sichelman, supra note 34, at 379 (introducing the concept of “data-generating patents” where the data produced can be maintained as a trade secret).
240 Hall et al., The Choice Between, supra note 8, at 419.
241 See Hertzfeld et al., supra note 220, at 830.
242 Id. at 826.
243 Id. at 832.
244 Helmers & Rogers, supra note 42, at 1018.
245 See Hall et al., The Choice Between, supra note 8, at 419 (“It might be worthwhile to relax the assumption that patents and secrecy are mutually exclusive and to consider a more complex and realistic scenario in which companies employ different mechanisms to protect the same invention.”).
solely use patents as the comparator. As such, there is a strong need for further study on how trade secrets interact with other appropriability mechanisms, especially for startup firms.

9. Open Questions Remaining from Previous Studies

As we have explained in our extensive review of the trade secrecy empirical literature, many gaps remain in our understanding of the usage of trade secrets, especially by startups. Of relevance to our study, there are three major areas ripe for exploration. First, how startups—particularly by industry—decide between the use of trade secrecy and other forms of intellectual property, such as patents, copyrights, and trademarks, and the role the cost of IP alternatives plays in this decision. Second, whether patents, as well as other forms of IP, and trade secrets can act as economic complements. Third, the extent to which startups use trade secrets to maintain first-mover advantage, relative to other functions, such as assisting in financing and strategic bargaining.

III. An Empirical Assessment of Startups and Trade Secrecy

In this Part, we discuss the results of the Berkeley Patent Survey as they pertain to trade secrets. As we noted earlier, although some of these results have previously been published, many have not, nor have any regression analyses been performed on the data. As such, and given that the Berkeley Patent Survey represents the largest dataset on startups and IP assembled to date, many of the findings presented here are the first comprehensive results regarding the use of trade secrets by startups.

246 A notable exception is Mann’s study of software companies. See Mann, supra note 70. In his survey based upon “60 interviews with a variety of professionals knowledgeable about the software industry,” he explains that “[c]opyrights and trade secrets . . . play an important role in protecting investments in software. But it is a role weighted in the opposite direction of the role that patents play; copyrights and trade secrets, to the extent they are useful, tend to support the efforts of large incumbent firms and to hinder the efforts of smaller entering firms seeking a foothold for competition.” Id. at 966, 1021 (footnotes omitted).
247 See supra Section IIA (describing the limited data on SMEs and the nonexistent data on startups per se); subsection II.B.4 (discussing the limited analysis of trade secrecy usage by industry).
248 See supra subsection II.B.8 (discussing the speculation that trade secrets and patents may act as complements, but noting the limited empirical support for the assertion).
249 See supra subsection I.A.5 (explaining the view that trade secrets may assist in financing and related activities, but noting the limited empirical support for the view).
250 See supra Introduction (describing the limited results released from 2008 Berkeley Patent Survey regarding trade secrets).
251 Graham et al., supra note 7, at 1255 (“[T]he 2008 Berkeley Patent Survey [is] the first comprehensive survey of patenting and entrepreneurship in the United States—summarizing the responses of 1,332 early-stage technology companies founded since 1998.”).
A. The Data: The Berkeley Patent Survey

In view of the paucity of information regarding the use of patents, trade secrets, copyrights, and trademarks by startups, one of the authors (Sichelman) and other investigators created and administered the first comprehensive survey targeted at U.S. startup and early-stage companies’ use of intellectual property, particularly patents, and the effects of third-party IP on those companies. Formally titled “The 2008 Berkeley Patent Survey: Entrepreneurial Companies and the Patent System,” the survey included a variety of questions focused not only on patents, but also trade secrets and other forms intellectual property, as they relate to company innovation, capital formation, business strategies, competition, and alternative forms of intellectual property protection.252

The survey was administered by mail, email, the internet, and telephone during 2008 to top executives, including CEOs, CTOs, and in-house counsel, at over 15,000 U.S. companies. Specifically, we253 targeted companies founded in the United States during the last ten years in the biotechnology, medical device, software,254 and hardware (including computer, semiconductor, and telecommunications equipment) sectors.255 We drew our sample from two extensive databases—Dun & Bradstreet (D&B) and Thomson’s VentureXpert (VX)—using both the Standard Industry Classification (SIC) and North American Industry Classification System (NAICS) to identify the applicable industry sectors of the respondents.256

The survey included about thirty questions.257 As background, the survey asked each company about its business strategy, revenues, number of employees, innovation focus, and ownership of patents.258 Although much of the survey focused on patents, the survey included several questions involv-

252 For a description of the survey’s genesis, including the rigorous process used to develop and vet the survey, see Graham & Sichelman, supra note 223, at 1091–96.

253 The use of “we” in this Section and the following two Sections generally refers to the four authors of the Graham et al. article. Graham et al., supra note 7, at 1255 (the authors are Stuart J.H. Graham, Robert P. Merges, Pam Samuelson, and Ted Sichelman).

254 Because of the large number of software firms founded during the period of interest, the investigators randomly selected 25% of those firms to include in our sample.

255 For companies in the dataset that received venture financing during the last ten years, over 75% are classified into the primary industries: “information” (61%) and “health” (15%). For the hardware industry, the investigators included only venture-backed firms in the dataset.

256 Sichelman & Graham, supra note 58, at 148–49 (“Our sample frame was drawn from two prominent databases—Dun & Bradstreet (D&B) and VentureXpert (VX) (Thomson)—using both the Standard Industry Classification (SIC) and North American Industry Classification System (NAICS) to identify companies in relevant industries.”).

257 See Graham et al., supra note 7, for a fairly comprehensive list of topics and questions included in the survey.

258 Sichelman & Graham, supra note 58, at 149 (“[W]e inquired about each respondent company’s background, revenues, number of employees, innovation focus, and patent ownership and use.”).
First, the survey asked about the relative importance of various means to profit from innovation, including patents, copyrights, trade secrets, trademarks, and non-IP barriers to entry, such as first-mover advantage. The survey then asked which of these appropriability mechanisms was the most important. Specifically, the questions were as follows:

How important or unimportant is each of the following in your company’s ability to capture competitive advantage from its technology innovations?

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<td>b. Patents</td>
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<td>f. Other production, implementation, or marketing capabilities deployed along with the innovation</td>
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</table>

Second, the survey inquired about the reasons for not patenting an innovation, including whether the company “did not want to disclose information.” Specifically, the survey asked the following questions:

259 See generally Graham et al., supra note 7, at 1288–89.

260 See id.

261 Sichelman & Graham, supra note 58, at 165. Importantly, the question uses the term “secrecy” rather than “trade secrecy” so it could compare results to the earlier survey of large companies by Cohen et al. See Graham et al., supra note 7, at 1291. Thus, the results may conflate “trade secrecy” with “secrecy.” Specifically, there are various practical and technical, but nonlegal, means of limiting access to certain (proprietary) information, such as passwords and digital signatures, technological means of preventing copying, and eliminating access to information after a particular date. See Hurmelinna-Laukkanen & Puumalainen, supra note 33, at 97.

262 See generally Sichelman & Graham, supra note 58, at 149 n.221.

263 Id. at 174.
"For that same unpatented innovation, which if any of the following influenced your company’s decision *not to patent*?" (Please check ✓ ALL that apply)

| a. Did not want to disclose information | □ |
| b. Cost of getting the patent, including attorneys’ fees | □ |
| c. Competitors could have easily invented around the patent | □ |
| d. Believed that trade secret was adequate protection | □ |
| e. Cost of enforcing the patent, including actions in court | □ |
| f. Did not believe the technology was patentable | □ |
| g. No need for legal protection | □ |

Which of these was the *most important* reason not to patent?

Enter a letter ________

In addition to the responses from these questions, in order to gain a richer understanding of what drove companies to use trade secret protection (or not) and whether trade secrecy was effective as an appropriability mechanism, we combine company information from the survey about patent holding, revenues, employees, and other characteristics to segment responses and form the basis of detailed regressions.264

**B. Response Rates and Respondent Characteristics**

1. **Survey Response Rates**

   Overall, the survey response rate for companies actually residing at the address provided from our data sources is roughly 12%—specifically, about 11% for Dun & Bradstreet (D&B) firms and 17% for Venture Expert (VX) companies.265 Within industries, the response rate for D&B biotechnology and medical device companies was about 24% (105 responses total); for VX biotechnology and medical device companies, 24% (139 responses); for D&B software companies, 9% (535 responses); and for VX software and hardware companies, 16% (242 responses). Although these response rates may seem somewhat low, they are quite typical for surveys of small companies.266

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264 See infra subsection III.C.1.d.
265 These response rates are adjusted for companies that we presumed to have moved or disbanded based on bad addresses and disconnected phone numbers. For additional discussion of response rates, see Graham et al., supra note 7, at 1271–72.
266 See Joseph J. Cordes et al., A Survey of High Technology Firms 10–11 (1999) (reporting response rates of 3.8% to 31% on small firm surveys).
Indeed, given that the majority of the respondents were CEOs and CTOs, whose time is usually in high demand, the response rates are respectable. Of course, any potentially low response rates raise the possibility for bias and skew, which we discuss in the next subsection.

2. Characteristics of Respondents

Using data from D&B, Thomson’s VX, and the U.S. Patent and Trademark Office, we compared several different characteristics of our respondent and nonrespondent samples. Specifically, we examined attributes such as age, size, geographic location, and number of patents held and, when available, annual revenue and features of the company’s venture funding. Generally, any differences in these characteristics are not statistically significant at conventional levels. Some notable exceptions are company location (in general, the respondents were located more in the western United States, especially the West Coast), and respondent medical device companies tended to have fewer employees than nonrespondents. There are also differences in patenting rates and revenues—notably in the software sector, which suggest that higher-patenting, higher-revenue companies were more likely to respond—although not at statistically significant levels. Despite these exceptions, the overall findings of little to no significant difference in company age, size, and patenting suggest that the respondents are fairly representative of the entire sample of companies.

267 See id.
268 Sichelman & Graham, supra note 58, at 150 (“Using data from Dun & Bradstreet, Thomson’s VentureXpert, and the U.S. Patent Office, we were able to compare several different variables of our respondent and non-respondent samples.”).
269 See id. (“We tested the mean statistics on attributes such as age, size, geographic location, and patents held—and, when available, annual revenue and features of the company’s venture funding.”).
270 See id. (“Generally, the differences in these variables are not statistically significant at conventional levels.”).
271 Medical device respondents in the D&B sample had an average of fourteen employees versus thirty-eight employees among the nonrespondents (significant at the 90% confidence interval). However, this difference is primarily driven by large outliers; at the median, our respondent medical device firms have the same number of employees as our nonrespondents (five).
272 Issued patents were calculated by examining and comparing data supplied from U.S. Patent and Trademark Office databases current through July 22, 2008. See Official Gazette for Patents, U.S. Pat. & Trademark Off., https://www.uspto.gov/learning-and-resources/official-gazette/official-gazette-patents (last visited Sept. 28, 2018). We also examined the number of published patent applications starting in the year 2001 using the same data. See id.
273 Sichelman & Graham, supra note 58, at 151 (“Despite these exceptions, our overall findings of little to no significant difference in age, size, and patenting suggest that our respondent companies are not different from the entire random sample of companies, at least in terms of these important characteristic attributes.”).
It is important to recognize, too, that “any bias in our sample is likely present—and in many instances to a greater degree—in previous surveys.” Indeed, no previous survey recounted earlier examined characteristics of their respondent sample against their nonrespondent sample. For example, the frequently cited Carnegie Mellon (Cohen et al.) and Yale (Levin et al.) surveys noted earlier—although having response rates of about 50%—disclosed no analysis comparing company size, revenues, market capitalization, patenting rates, or other important characteristics of respondents with nonrespondents.

Finally, as another test for bias, we employed a variety of statistical methods to compare the results of the responses we received in response to hard-copy mailings and emails (approximately 1200) and those responding to a telephone campaign (approximately 130). In this regard, in the first phase of contacting companies, we only used mail and email; thus, the companies responding by phone are initial nonrespondents. Moreover, unlike our mail and email respondents, most of the telephone-based respondents received (and, to a large degree, required) a gift certificate “prize” for completing the survey. Overall, we found no statistically significant differences between the responses of these two groups—including comparisons just of software firms, which had the lowest response rates. Given these findings, we do not view the differences in background characteristics reported above as problematic.

C. The Results: The Use of Trade Secrets by Startups Highly Varies

In what follows, we first provide descriptive results of the relevant survey responses—overall as well as segmented by a variety of important company characteristics, such as industry, company age, and size of patent portfolio. Then, we perform several regressions on the results to pinpoint those factors.

274 Id. at 151.
275 Id.
276 Id. at 151–52.
277 Id. at 152.
278 We contacted the original set of respondents by email and standard mail from June to August 2008, then called about 13% of the nonrespondents beginning in September 2008.
279 After testing, we determined that a large share of the telephoned sample needed to be motivated by a guaranteed “prize”—in this case, a $25–50 gift certificate for Amazon—to take the survey.
280 Sichelman & Graham, supra note 58, at 152 (“Importantly, based on our testing to date, we have found no statistically significant differences between the responses of these two groups—including comparisons just of software firms, which had the lowest response rates.”).
281 Id. at 152 (“Given these findings, we believe that we have by and large insulated ourselves from the charge that differences in background characteristics reported above are problematic.”).
282 See infra subsection III.C.1.c.
and company characteristics that drive the use (and non-use)—as well as general effectiveness—of trade secrets among startups.\(^{283}\)

1. Descriptive Results

a. Importance of Trade Secrecy Relative to Other Appropriability Mechanisms

As noted in Part II, previous surveys found that trade secrecy was often more important for large companies that many other appropriability mechanisms.\(^{284}\) Prior to the Berkeley Patent Survey, there was no systematic investigation of whether this result held for startups.\(^{285}\)

![Figure 1: Importance of Appropriability Mechanisms](image)

**Figure 1:** Importance of Appropriability Mechanisms

(4 = very important; 3 = moderately important; 2 = slightly important; 1 = not important at all)

How important or unimportant is each of the following in your company’s ability to capture competitive advantage from its technology innovations?

As shown in Figure 1, secrecy was the third most important appropriability mechanism for biotechnology companies with a rating of 3.16 (slightly more “moderately important”).\(^{286}\) However, while patents and first-mover advantage had nominally higher scores, the differences were not statistically significant.\(^{287}\) Additionally, it is clear that secrecy provided a greater advantage to biotech startups than mere reverse engineering, which was rated a 2.52 (between “moderately” and “slightly” important).\(^{288}\) Similarly,

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283 See infra subsection III.C.2.
284 See supra Section II.A.
285 See supra Introduction.
286 Figure 1 shows the results for the Dun & Bradstreet respondents, which represent the “population” of companies in our sample. See Graham et al., supra note 7, at 1269. The VentureXpert respondents showed very similar variation. See id. at 1270 & n.45.
287 See supra Figure 1.
288 See supra Figure 1.
for medical device companies, secrecy stood just behind first-mover advantage and patents—and greatly exceeded the value of reverse engineering.\textsuperscript{289} Thus, for startup biomedical companies, the importance of secrecy to capture competitive advantage was paramount.\textsuperscript{289}

Within the software industry, however, secrecy was significantly less important than first-mover advantage, copyright, and other production, implementation, or marketing capabilities.\textsuperscript{291} Secrecy was roughly of the same importance as trademarks and the difficulty of reverse engineering (the latter of which is intuitive and should be of similar importance, since a major factor in keeping client-based software innovations secret is the difficulty of reverse engineering them, and reverse engineering is one of the primary ways to relinquish a trade secret). Yet, secrecy was more important than patents for respondents in the software industry.\textsuperscript{292}

These results are notable for two reasons. First, they show significant variation among startups by industry. In biotechnology, trade secrecy is critical, but much less so for software. This is sensible given that many biotechnology inventions—especially processes—can easily be kept secret.\textsuperscript{293} In this regard, respondents reported that when deciding not to patent inventions, when the invention was a process, 41% of the time this was because trade secrecy was adequate, but for product inventions, trade secrecy was adequate only 34% of the time.\textsuperscript{294} Software, on the other hand, is much more susceptible to reverse engineering—whether simply by examining functionality or by so-called decompiling to recreate source code.\textsuperscript{295}

Interestingly, despite the ease with which software can be reverse engineered—hence, diminishing the importance of trade secrecy—as well as the reported ineffectiveness of patenting, software companies still relied heavily on first-mover advantage.\textsuperscript{296} Thus, network effects, branding, client relationships, and other barriers to entry must play stronger roles than patents or

\textsuperscript{289} Graham et al., supra note 7, at 1291 & n.112 (“For medical device startups and venture-backed IT hardware companies, respondents rank patenting second, behind first-mover advantage.”).

\textsuperscript{290} Cf. id. at 1291 & n.113 (“For this group of firms, patenting is ranked as the most important means of capturing competitive advantage.”).

\textsuperscript{291} These differences are significant at a 99% confidence level (first-mover advantage) and a 90% confidence level (copyright and other production, implementation, or marketing capabilities).

\textsuperscript{292} This difference is significant at a 99% confidence level.

\textsuperscript{293} Graham et al., supra note 7, at 1313 (“Biotechnology firms are also more likely to believe that trade secret is an adequate means of protecting their innovations . . . .”)

\textsuperscript{294} See infra Appendix, Figure A1. These differences are statistically significant at a 99% confidence level.

\textsuperscript{295} See, e.g., Erika Danielle Norman, Weak Overseas Protection for American Software Patents: The Need for a Congressional Response to Microsoft Corp. v. AT & T Corp., 8 Chi.-Kent J. Intell. Prop. 111, 134 (2008) (“[It is not possible to reverse-engineer genetic code (as it is computer software) through the use of instructions . . . .”).

\textsuperscript{296} See supra Figure 1.
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Additionally, like patents, these results support the view that trade secrecy usage is industry specific.298

Second, these results show important differences from the previous large-company surveys. For instance, in the Cohen et al. survey, secrecy was ranked as more important than patenting even for pharmaceutical and biotechnology companies.299 In contrast, for biotech startups, patenting was at least of equal importance to secrecy. Although earlier large-company studies did not focus on software companies, they did survey electronics hardware companies, such as those in the semiconductor industry.300 Like healthcare startups, IT hardware firms rated secrecy as more important than patenting in the earlier surveys.301 However, for venture-backed IT hardware startups in the Berkeley Patent Study, patenting was at least as important as secrecy.302

b. Trade Secrets and Patents as Substitutes or Complements?

As recounted earlier, there is a vigorous debate among theorists and conflicting results in the empirical studies as to whether trade secrets and patents act as economic substitutes or complements.303 The responses here can help answer that question—at least as to startups—because we can measure the relative importance of patents and trade secrets as a company’s patent portfolio grows in size. Additionally, we can measure the extent to which disclosure is a reason for not applying for a patent, across and between industries.


298 See generally Dan L. Burk & Mark A. Lemley, Policy Levers in Patent Law, 89 Va. L. Rev. 1575, 1650 (2003) (contending that patent law is applied in an industry-specific manner). There is a dire need for understanding industry-specific application of doctrine, especially in trade secrecy. See Philip Craft, David Levine Speaks at Two Forums on Information, Technology and Media, ELON U. (May 29, 2013), http://www.elon.edu/e-net/Article/72117?s=/Law/news/enet_navigation (reporting on a presentation by one of the authors (Levine) regarding the “potential for future conflict between people seeking information in various fields (finance, media, energy, etc.) and firms who wish to preserve the secrecy of their methods”).

299 See Cohen et al., supra note 165, at 10, 13, 40 fig.1.

300 Graham et al., supra note 7, at 1290–92 (“[I]n the 1994 Carnegie-Mellon Survey, IT hardware firms (such as semiconductors and communications equipment) reported that patenting was only effective at protecting about one-quarter of their product innovations, compared with secrecy, which was effective at protecting about one-half.”).

301 See id. at 1291–92.

302 See id. at 1292 & n.118. (“While the average importance given to patents is greater than that of secrecy, the difference is not statistically significant at conventional levels.”)

303 See supra Parts I–II.
Specifically, Figure 2 shows the relationship between the number of patents held by a company and the importance reported for each of the four appropriability mechanisms: patents, reverse engineering, secrecy, and first-mover advantage. Critically, the importance of secrecy increases with number of patents held. For instance, the average importance of secrecy for companies with no patents (mean = 2.47) is significantly less than for those with 100 to 200 patents (mean = 3.33) and with over 300 patents (mean = 4.00).304 In addition, for respondents with no patents, secrecy is less important than first-mover advantage, roughly the same importance as the difficulty of reverse engineering, and more important than patents.305 For those with 100 to 200 patents, secrecy is less important than patenting, less important than reverse engineering, and roughly the same importance as first-mover advantage.306 For those companies with more than 300 patents, the importance of patents, secrecy, and first-mover advantage were all reported as “very important” (mean = 4.00), while reverse engineering was least important (mean = 2.00).307

These results are important because they provide support for the theory that patents and trade secrets may act as complements, at least for companies that hold many patents. Further supporting this view, in Figure A1...
(Appendix) we report that the companies that marked “trade secrecy as adequate” and “did not want to disclose information” as the most important reason not to patent a recent invention held more patents than companies reporting other reasons (such as cost). 308 What the results do not show is whether this complementary relationship is one that exists prior to patenting, after patenting, or both. However, as we show in our regression analysis, a major driver affecting the importance of patenting for companies is the importance of trade secrecy and vice-versa, and this relationship is not affected by company age, size, or revenue. 309 Although not determinative, this result indicates that the complementary relationship exists both prior to and after patenting. 310 At the same time, our results also show that patents and trade secrets may—per the traditional model—act as substitutes. 311 Specifically, Figure 3 shows seven factors that may have influenced the respondent company’s last decision not to patent, segmented by industry. 312

\[ \text{FIGURE 3: REASONS NOT TO PATENT BY INDUSTRY TYPE} \]

For that same unpatented innovation, which if any of the following influenced your company’s decision not to patent?

![Diagram showing reasons not to patent by industry type]

As shown in Figure 3, firms in all industries report that they, at least in part, decided not to patent a recent invention because “trade secrecy was adequate protection” and they “did not want to disclose information” in a

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308 These differences are significant at a 99% confidence level.
309 See infra subsection III.C.2.
310 See infra subsection III.C.2.
311 See supra Section I.A.
312 The difference in the percentages shown in Figure 3 are significant to a 99% confidence level.
patent. Specifically, roughly 45–48% of companies in the biotechnology, medical device, and IT hardware industries, and 29% of software companies, reported that trade secrecy was adequate. Nearly 59% of biotech companies reported that they did not patent a previous invention because they did not want to disclose information, followed by 50% of IT hardware companies, 45.5% of medical device companies, and 25% of software companies. The results indicate that, at least in many situations, patents and trade secrets function as substitutes.

Thus, as more sophisticated theories have posited, our data lends support to the claim that trade secrets may function both as substitutes and as complements, depending on the circumstances at hand.313

c. “New” vs. “Old” Startups

There is some evidence that as a company matures, it becomes less dependent on patents and more dependent on trade secrecy.314 Because our sample of companies essentially ranged from zero to ten years old, we examined whether the respondents changed their ratings of appropriability mechanisms by the age of the company.315

FIGURE 4: YEAR COMPANY FOUNDED COMPARED TO THE IMPORTANCE OF APPROPRIABILITY MECHANISMS

Specifically, Figure 4 shows the relationship between the year a company was founded and the importance it gives to each of the four appropriability mechanisms: patents, reverse engineering, secrecy, and first-mover advantage. In general, respondents gave the same average importance to secrecy

313 See Simon & Sichelman, supra note 34, at 383–84 (posing patents and trade secrets as both substitutes and complements).
314 See supra subsection II.B.4.
315 See infra Figure 4.
Why Do Startups Use Trade Secrets?

regardless of their age group. In addition, respondents generally assigned secrecy the same relative importance—less than first-mover advantage, similar to patents, and more than the difficulty of reverse engineering—across all three age groups. Thus, it appears that, at least among young companies, there is little change from initial founding as the company matures. Similarly, we find that from the smallest to the largest startups—as measured by the number of employees—trade secrecy remains of about equal importance. On the other hand, unlike segmenting companies by age, patents generally become less important relative to trade secrecy as a company’s number of employees grow. Thus, it appears that size may matter more than age in determining the relative importance of patents and trade secrets, as well as other forms of intellectual property.

d. Important of Secrecy by Business Model

Presumably, companies primarily providing services are less concerned with trade secrets than companies providing products. On the other hand, scholars have generally viewed companies licensing inventions to rely more heavily on patenting than trade secrecy, because as we noted earlier, Arrow’s information disclosure paradox holds that it is impossible to license absent disclosure (which, absent a nondisclosure agreement, would destroy secrecy). However, to the extent that Burstein is correct that information in licensing deals can be disclosed in layers, trade secrecy would still play a critical role.

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316 This similarity is significant at a 90% confidence level.
317 The difference between the importance of secrecy and the importance of first-mover advantage, and the difference between the importance of secrecy and the importance of reverse engineering are statistically significant at a 99% confidence level across all three age groups. The difference between the importance of secrecy and the importance of patents is not significant in any age group except for companies founded before 2000.
318 See infra Appendix, Figure A3.
319 See infra Appendix, Figure A3.
320 See infra Appendix, Figure A3.
321 See supra notes 113–19 and accompanying text.
322 See supra notes 117–19 and accompanying text.
Figure 5: Secrecy Compared to Sources of Revenue

Figure 5 shows the relationship between the proportion of revenue a company derives from each of three sources—selling products, selling services, and licensing technologies—and the corresponding importance such companies give to secrecy as an appropriability mechanism. Of companies deriving a majority of their revenue from a single source, those deriving most of their revenue from licensing technologies considered secrecy to be more important on average than companies deriving most of their revenue from selling products.\(^{323}\) Companies deriving most of their revenue from selling products considered secrecy to be more important on average than companies deriving most of their revenue from selling services.\(^{324}\)

In this regard, the proportion of revenue derived from selling products has no real correlation with the importance of secrecy.\(^{325}\) On the other hand, the importance of secrecy has a weak but statistically significant inverse correlation with the proportion of company revenue derived from selling services; as the proportion of revenue derived from selling services increases, the importance of secrecy decreases. Conversely, the importance of secrecy has a weak but statistically significant positive correlation with the proportion of company revenue derived from licensing technologies; as the proportion of revenue derived from licensing technologies increases, so too does the importance of secrecy.

These findings are important in two major ways. First, they support the view that trade secrecy is more important to product-focused companies than service-focused companies. In this regard, other results show that for startups deriving most of their revenue from product sales, there is no statisti-

\(^{323}\) This difference is significant at a 99% confidence level.

\(^{324}\) This difference is significant at a 99% confidence level.

\(^{325}\) The \(p\)-value of interest is 0.40.
cally significant difference between the importance of patents and the importance of trade secrets.\textsuperscript{326}

Second, and perhaps most importantly, these findings support the importance of trade secrets to companies engaged in licensing. Indeed, other data shows that for startups deriving most of their revenue from licensing, there is no statistically significant difference between the importance of patents and the importance of trade secrets.\textsuperscript{327} As such, this finding is in some tension with Arrow’s information disclosure paradox—since it is clear that not all licensees will sign nondisclosure agreements—and lends support to Burstein’s view that information can be disclosed in layers.\textsuperscript{328}

2. Regression Models

Here, in order to pinpoint the drivers of trade secrecy usage and effectiveness, we employ multivariate ordered logistic regression techniques.\textsuperscript{329} Specifically, because mere descriptive results may be explained by other variables, we construct a set of explanatory variables to test against the results of the survey questions. We first describe those variables, then the results of our regression models.\textsuperscript{330}

a. Explanatory Variables

There are many factors that could influence trade secrecy usage and effectiveness among startups. For instance, as already seen in the descriptive statistics, results varied by industry, number of patents held, innovation type (product or process), and business model (product, process, or licensing). We use these and a variety of other explanatory variables. Additional variables include company age, funder types, number of employees, revenue, and business strategy. These and other variables, including those representing responses, are described in Table 1 below.

\textsuperscript{326} The \( p \)-value for this difference is approximately 0.64.
\textsuperscript{327} The \( p \)-value for this difference is approximately 0.64.
\textsuperscript{328} See supra notes113–19 and accompanying text. An alternative hypothesis is that licenses involving less valuable information can rely on trade secrecy for protection, while licenses involving more valuable information must rely on patents (or other mechanisms) for protection. We thank Michael Risch for this suggestion. Although our results do not rule out this alternative hypothesis, all other factors equal, they nonetheless lend support to Burstein’s view that Arrow’s information disclosure paradox may not always hold, at least as traditionally conceived.
\textsuperscript{329} We thank Shawn P. Miller, Intellectual Property Research Fellow at Stanford Law School, for his assistance in performing the regressions.
\textsuperscript{330} The two dependent variables we utilize in our analysis—the importance of secrecy and the importance of patents—each possess more than two ordinal values and the Likert-scale values (1, 2, 3 or 4) possess a meaningful sequential order. Accordingly, we use the ordered logit model in our regressions. See generally Peter McCullagh, \textit{Regression Models for Ordinal Data}, 42 J. ROYAL STAT. SOC’Y. 109 (1980).
### Table 1: List of Explanatory and Survey Response Variables

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>agein2008</td>
<td>Age of company in 2008</td>
</tr>
<tr>
<td>angelfunded</td>
<td>The company was funded by angel investors</td>
</tr>
<tr>
<td>cbankfunded</td>
<td>The company was funded by commercial banks (credit, loans)</td>
</tr>
<tr>
<td>complementassets</td>
<td>Importance of other production, implementation, or marketing capabilities as appropriability mechanisms</td>
</tr>
<tr>
<td>copyright</td>
<td>Importance of copyright as an appropriability mechanism</td>
</tr>
<tr>
<td>employs</td>
<td>Number of employees at the end of 2007</td>
</tr>
<tr>
<td>firstmover</td>
<td>Importance of first mover advantage as an appropriability mechanism</td>
</tr>
<tr>
<td>friendsfunded</td>
<td>The company was funded by friends and family</td>
</tr>
<tr>
<td>ibankfunded</td>
<td>The company was funded by investment banks</td>
</tr>
<tr>
<td>ind</td>
<td>Combined (VX and DB) industry indicator</td>
</tr>
<tr>
<td>licenseout</td>
<td>Percent share of revenue from licensing tech</td>
</tr>
<tr>
<td>num patents</td>
<td>Number of patents held</td>
</tr>
<tr>
<td>otherfunded</td>
<td>The company was funded by other companies as investors</td>
</tr>
<tr>
<td>patents</td>
<td>Importance of patents as an appropriability mechanism</td>
</tr>
<tr>
<td>revenue</td>
<td>Revenue in millions of dollars</td>
</tr>
<tr>
<td>reverseeng</td>
<td>Importance of the difficulty of reverse engineering as an appropriability mechanism</td>
</tr>
<tr>
<td>secrecy</td>
<td>Importance of secrecy as an appropriability mechanism</td>
</tr>
<tr>
<td>sellprod</td>
<td>Percent share of revenue from selling products</td>
</tr>
<tr>
<td>sellservice</td>
<td>Percent share of revenue from selling services</td>
</tr>
<tr>
<td>shareeng</td>
<td>Percent share of employees that were engineers</td>
</tr>
<tr>
<td>strategydesign</td>
<td>Importance of design innovation to business strategy</td>
</tr>
<tr>
<td>strategymodel</td>
<td>Importance of business model innovation to business strategy</td>
</tr>
<tr>
<td>strategyprocess</td>
<td>Importance of process/internal tools innovation to business strategy</td>
</tr>
<tr>
<td>strategyprod</td>
<td>Importance of product innovation to business strategy</td>
</tr>
<tr>
<td>trademarks</td>
<td>Importance of trademarks as an appropriability mechanism</td>
</tr>
<tr>
<td>vcfunded</td>
<td>The company was funded by venture capital investors</td>
</tr>
</tbody>
</table>
3. Regression Results
   a. General Trends

   We began by measuring the relationship between numerous variables and the rating of the importance of secrecy (on the 1–4 scale) in obtaining competitive advantage for a company’s innovations. In the first model, we did not control for industry or funding type.331

   **Table 2: The Importance of Secrecy: Regression Model 1**

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Coeff332</th>
</tr>
</thead>
<tbody>
<tr>
<td>patents</td>
<td>0.55***</td>
</tr>
<tr>
<td>firstmover</td>
<td>0.56***</td>
</tr>
<tr>
<td>reverseeng</td>
<td>0.36***</td>
</tr>
<tr>
<td>strategyprod</td>
<td>0.15</td>
</tr>
<tr>
<td>trademarks</td>
<td>-0.00</td>
</tr>
<tr>
<td>complementassets</td>
<td>0.23***</td>
</tr>
<tr>
<td>copyright</td>
<td>0.07</td>
</tr>
<tr>
<td>strategydesign</td>
<td>0.13*</td>
</tr>
<tr>
<td>strategyprocess</td>
<td>0.34***</td>
</tr>
<tr>
<td>shareeng</td>
<td>0.32</td>
</tr>
<tr>
<td>strategymodel</td>
<td>-0.13</td>
</tr>
<tr>
<td>employs</td>
<td>0.001</td>
</tr>
<tr>
<td>revenue</td>
<td>1.9e-7</td>
</tr>
<tr>
<td>agein2008</td>
<td>0.026</td>
</tr>
<tr>
<td>sellservice</td>
<td>-0.22</td>
</tr>
<tr>
<td>sellprod</td>
<td>-0.43*</td>
</tr>
</tbody>
</table>

   As shown in Table 1, many explanatory variables were statistically significant.333 For instance, companies that ranked patents higher also ranked

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331 Because not all respondents answered all of the questions related to the variables in Table 1, we ran six different models, omitting number of patents, percentage share of revenue from licensing technology, percentage share from selling a service, and percentage share from selling a product in various combinations in each model. The table reported here includes percentage share from selling a service and percentage share from selling a product. The other models are available in the Appendix, with results that are substantially the same as those presented here.

332 Here, the stars indicate statistical significance at least a 99% confidence level (**), 95% confidence level (*), and 90% confidence level (*). 

333 Because we performed cross-sectional regressions, there is very likely to be some endogeneity between our dependent and independent variables—namely, that the value of trade secrecy likely drives the value of some of our independent variables. For instance, the value of trade secrecy may itself increase the value of patenting, or allow more employees to be hired. Thus, our regressions cannot be interpreted in a wholly causal fashion.
trade secrecy higher. This is strong support for the view that trade secrets and patents can function as economic complements. On the other hand, there was no statistically significant relationship between the importance of trade secrecy and the importance of copyrights and trademarks, indicating that these forms of IP may not act as complements (or substitutes for that matter) for trade secrets.

Additionally, companies that rated first-mover advantage, the difficulty of reverse engineering, and complementary assets higher on average also rated trade secrecy higher. These results help to confirm the traditional model that views trade secrecy as important to maintaining first-mover advantage for difficult-to-reverse-engineer innovations. These results hold even for larger companies that rate highly the importance of complementary assets, such as marketing muscle, access to capital, and production capabilities. Indeed, there was no statistically significant relationship between revenue, the number of employees, or age and how a company rated the importance of trade secrecy.

Next, the regressions show business strategy is significantly related to the importance of trade secrecy. Those companies that ranked design and process innovation higher rated trade secrecy higher, while there was weak evidence that those companies earning revenue primarily from products rated trade secrecy lower. These results comport with the general understanding that process innovations are better protected through trade secrecy.334 Consistent with our descriptive findings, companies that mainly earned revenue from licensing showed an increase in reliance on trade secrets, though there were too few data points for this finding to be statistically significant.335

In an alternative model, we added dummies for the four industries of interest, with the statistically significant result that software companies tend to rate trade secrecy as less important.336 In yet another model, we examined whether the type of funding was related to whether a respondent company rated trade secrecy as more important. Specifically, we found weak evidence that when controlling for factors other than industry, traditional

Nonetheless, the results show general, empirical relationships between potential explanatory factors and the role of trade secrecy in technology startups and thus provide valuable insight into the likely causal mechanisms underlying the importance of trade secrecy.

334 See supra notes 197–200 and accompanying text. Earlier we reported that product-based companies rated trade secrecy as more important than service-based companies. See supra notes 322–23 and accompanying text. The finding here relates not to the type of revenue derived by the company, but rather to its types of innovations. Thus, a product-based company will typically generate both product-based innovations (i.e., in the product itself) and process-based innovations (e.g., in manufacturing), and the result here shows that trade secrecy was rated as more important for process innovations than product innovations.

335 See infra Appendix, Table A2.

336 See infra Appendix, Table A3. Results were significant at a 95% or greater confidence interval. On the other hand, we found no statistically significant relationship between the medical device, IT hardware, and biotech industries and the importance of trade secrecy, though this simply could reflect too small a sample size for these industries.
venture capital firms found trade secrecy to be less important to their investment decisions.\textsuperscript{337} Because most companies funded by venture capital (VC) firms in our sample were software companies, this result probably more affirms the lesser importance of trade secrets for software startups than indicates a general lack of concern for trade secrets by VCs across all industries. Yet, at least for software startups in 2008, VCs appeared much more concerned about patents than trade secrets.\textsuperscript{338} In the wake of substantial restrictions on the Patenting of software erected by recent U.S. Supreme Court decisions, these results could very well be different today.\textsuperscript{339}

b. Secrecy vs. Patenting

Our results in the previous section underscore that patents and trade secrets can act as economic complements. In order to better understand how patents and trade secrets can act as economic substitutes, we analyzed how key explanatory variables related to trade secrecy affected respondent company reporting regarding the importance of patents.\textsuperscript{340}

\textsuperscript{337} See infra Appendix, Table A5. This result was significant at a 90\% or a greater confidence level. There were no statistically significant relationships between the importance of trade secrecy and whether the respondent company was funded by an investment bank, commercial bank, angel investors, or family and friends. Like our industry results, this could simply reflect the relatively low sample size for these entities.

\textsuperscript{338} See Graham et al., supra note 7, at 1280 (“[V]enture investors are interested in patents, and venture-capital backed companies are much more likely to hold and file for patents.”).

\textsuperscript{339} See supra notes 45–54 and accompanying text.

\textsuperscript{340} Because not all respondents answered all of the questions related to the variables in Table 2, like the previous regressions, we ran six different models, omitting number of patents, percentage share of revenue from licensing technology, percentage share from selling a service, and percentage share from selling a product in various combinations in each model. The table reported here includes percentage share from selling a service and percentage share from selling a product. The other models are available in the Appendix, with results that are substantially the same as those presented here.
TABLE 3: THE IMPORTANCE OF PATENTING: REGRESSION MODEL

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Coeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>secrecy</td>
<td>0.69***</td>
</tr>
<tr>
<td>firstmover</td>
<td>0.27***</td>
</tr>
<tr>
<td>reverseeng</td>
<td>0.25***</td>
</tr>
<tr>
<td>strategyprom</td>
<td>0.49***</td>
</tr>
<tr>
<td>trademarks</td>
<td>0.45***</td>
</tr>
<tr>
<td>complementassets</td>
<td>-0.13</td>
</tr>
<tr>
<td>copyright</td>
<td>-0.08</td>
</tr>
<tr>
<td>strategydesign</td>
<td>0.008</td>
</tr>
<tr>
<td>strategyprocess</td>
<td>0.017</td>
</tr>
<tr>
<td>shareeng</td>
<td>0.59**</td>
</tr>
<tr>
<td>strategymodel</td>
<td>-0.01</td>
</tr>
<tr>
<td>employs</td>
<td>0.00</td>
</tr>
<tr>
<td>revenue</td>
<td>-1.8e-7</td>
</tr>
<tr>
<td>agein2008</td>
<td>-0.017</td>
</tr>
<tr>
<td>sellservice</td>
<td>-2.40***</td>
</tr>
<tr>
<td>sellprod</td>
<td>-1.36***</td>
</tr>
</tbody>
</table>

Interestingly, the most important factor for a company in rating patents as relatively important was whether the company rated trade secrecy as important. This finding is consistent with our descriptive findings that—at least portfolio-wide—patenting and trade secrecy act as complements.

Yet, we showed earlier that for a single innovation, not wanting to disclose information and using trade secrecy were important reasons companies identified for forgoing patenting. Thus, our results support the view that trade secrets can act both as complements (at a portfolio level) and as substitutes (at an innovation level). Of course, this does not rule out that trade secrets can act as complements even at the innovation level, but further research is needed to confirm or reject such a phenomenon.

IV. IMPLICATIONS OF OUR RESULTS: THE VARIED USES OF TRADE SECRETS

Here, we make some initial observations regarding the theoretical and empirical implications of our results. To be certain, these are not the only implications of our results, but ones that are novel, important findings in the ongoing and increasingly complex debate over the role of trade secrecy in industry and society.
A. The Role of Trade Secrecy in Promoting First-Mover Advantage

As we explained earlier, one of the primary reasons for trade secret use is to maintain lead-time advantage. Our results provide mixed support for this theoretical observation. For biotechnology startups, secrecy, patents, and first-mover advantage were indistinguishable statistically. This provides some support for the view that trade secrecy, along with patents, effectively extend first-mover advantage in order to secure supracOMPETITIVE profits in the marketplace.

On the other hand, for software startups, secrecy ranked more important than the other three forms of intellectual property law protection—copyrights, patents, and trademarks—but significantly lagged behind first-mover advantage as a means to capture advantage from innovation. Remarkably, startups in the software space do not view trade secrecy as synonymous with first-mover advantage, a result that flies in the face of the general assumption that trade secrecy is the engine of the first-mover advantage. Yet, as noted earlier, continuous advancement over competitors, network effects, branding benefits, and other barriers to entry can lead to similar lead-time advantages. This finding is important, as it lends some support for the view that robust trade secret protection is unnecessary in fields where software plays an important role, and calls into question the received wisdom of trade secrecy as a uniform, necessary prerequisite to all innovation.

Because startups do not necessarily view secrecy as a prerequisite to lead-time advantages, further study is needed to determine how firms understand the relationship between first-mover advantage and trade secrecy. More broadly, if secrecy is not as big a part of first-mover advantage as previously assumed—and other forms of IP, such as patents, do not take its place—then “open source” business models and other information diffusion innovation strategies may have more currency. Thus, it is not surprising that our findings only indicate substantial variation between secrecy and first-mover advantage for software companies, for which open source business models, network effects, and other mechanisms are more likely to lead to competitive advantage than for biotech, medical device, and IT hardware companies.

See supra subsection I.A.1.
See supra subsection I.A.1.
See supra notes 204–06 and accompanying text.
See supra Figure 1.
See Hurmelinna-Laukkanen & Puumalainen, supra note 33, at 103.
See supra subsection II.B.3.
See, e.g., David S. Levine, Confidentiality Creep and Opportunistic Privacy, 20 Tul. J. Tech. & Intell. Prop. 11, 39 (2017) (contending that, in the aftermath of the alleged Russian interference with the 2016 U.S. presidential election, there is a need for public access to the algorithmic code (i.e., software) used by Facebook, in order to understand how much information was actually shared and how to prevent such interference in the future).
See supra note 147 and accompanying text.
See supra note 147 and accompanying text.
B. Trade Secrets and Patents as Substitutes and Complements

As we discussed earlier, another major finding involves trade secrecy both as a substitute and as a complement to the expensive patent.350 As a general matter, trade secret scholarship has assumed a substitute relationship between trade secrets and patents, with the result that—all other factors being equal—firms will choose trade secrecy over patents because of the higher costs associated with acquiring a patent.351 Such a view is consistent with the findings of the large-company surveys of Cohen et al. and Levin et al., which generally showed a preference for secrecy over patenting.352

One would assume this effect would be even more pronounced for startups, given that they often lack adequate financing, rendering the cost of patenting prohibitively expensive.353 To a notable extent, our results seem to confirm this basic logic. The cost of obtaining a patent is the leading reason for not acquiring one; indeed, in the case of software startups, 63.5% listed it as a reason for forgoing patenting.354 This finding is at first blush in tension with the finding that a little over 29% of those same software startups indicated that trade secrecy was adequate protection.355 Nonetheless, it would seem that many startups, faced with the choice of patenting or not, may choose trade secrecy by default (even if they do not identify their non-patented information as such).356 In other words, for many startups, particularly in the software industry, trade secrecy may not be viewed as adequate, but it will have to do given the alternative of a cost-prohibitive patent.

But an alternative explanation, and another major finding of this study, is the possibility that startups view trade secrecy and patents as complements rather than substitutes.357 There are at least three possibilities here. First, startups use trade secrecy and patents in tandem for the same information and ideas, based on how best it might be protected at a given stage of development (i.e., research and development versus marketing).358 Second, to the extent that not all information concerning an invention must be disclosed in a patent, companies can simultaneously protect the same invention via a patent and trade secret.359 Last, as one of us has suggested elsewhere, a

350 See supra subsection III.C.1.b.
351 See subsection I.A.3.
352 See supra note 210 and accompanying text.
353 See Graham et al., supra note 7, at 1310–11.
354 See supra Figure 3.
355 See supra Figure 3.
356 To that end, it should be noted that “believed trade secret was adequate protection” and “did not want to disclose information” had similar propensities among the variables in foregoing patents. See supra Figure 3. Thus, it would seem that respondents seemed to understand that trade secrecy and preventing disclosure are correlated. That said, biotech startups were more interested in secrecy, it seems, given that it was a higher percentage answer than the cost of patenting in foregoing patents. See supra Figure 3. These results warrant further study and should be tested in future work.
357 See supra subsection III.C.1.b.
358 See Esmond et al., supra note 49, at 4; supra text accompanying note 49.
359 See supra note 89.
company with a “data-generating patent” can patent a means of collecting data, then protect the data itself via a trade secret.\(^{360}\)

To the extent that trade secrets may provide an additional layer of protection to patented inventions, this is another result that warrants further study, particularly given the new federal trade secret law, the DTSA, and its potential to increase the profile of trade secrecy as a litigation and remedial avenue.\(^{361}\)

**C. Trade Secrets as Strategic IP Assets**

Finally, our results indicate that trade secrecy is viewed among companies as enabling licensing revenue and strategic bargaining leverage for startups, supporting the theoretical view that trade secrets can function like traditional intellectual property.\(^{362}\) This finding is supported not only directly, but also in a variety of other responses. For instance, among companies that derive their revenue from a single source, those deriving most of their revenue from licensing considered secrecy as more important than those who primarily generate revenue through product sales.\(^{363}\) Indeed, the weak but significant positive correlation between the increasing proportion of revenue generated from licensing and trade secrecy provides empirical support for the claim that, like patents, trade secrets can act as important components in setting the boundaries of technology firms.\(^{364}\) As noted earlier, the findings help support Burstein’s claim that trade secrets play a central role in protecting firms negotiating with other firms over information assets and, that contrary to Arrow’s information disclosure paradox, trade secrets can allow information to be disclosed in layers so as to prevent expropriation.\(^{365}\)

\(^{360}\) See Simon & Sichelman, supra note 34, at 379.

\(^{361}\) See generally Levine & Seaman, supra note 3.

\(^{362}\) See Lemley, supra note 31, at 313 (“I suggest that trade secrets can be justified as a form, not of traditional property, but of intellectual property. . . . Granting legal protection for those new inventions not only encourages their creation, but enables an inventor to sell her idea.”).

\(^{363}\) See supra Figure 5.

\(^{364}\) See 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, 608 (“Trade secrets are valuable and frequently critical information to the functioning of firms, and are likely to be among the most firm-specific of intellectual assets—specialized processes, customer lists, business plans, and other information integral to the firm.”).

\(^{365}\) See supra notes 113–19 and accompanying text. On the other hand, in a separate set of regressions (available upon request), we found that other variables predicted the importance of secrecy more than licensing, including the importance of patents, first-mover advantage, reverse engineering, and product and process business strategies. Yet, this might be expected, given that most firms use trade secrets in more traditional ways. In our view, more data—specifically from industries in which licensing out plays a central role—is needed to more fully understand the role trade secrets play in licensing negotiations and the boundary of the firm.
CONCLUSION

The central aim of intellectual property law is to encourage new innovations—which, in turn, spawns new business enterprises—for society’s benefit. One key pillar of intellectual property law today is the law of trade secrecy. Yet, oddly, very little empirical research has focused on the usage and effectiveness of trade secrecy for startups. This lacuna is particularly problematic given that sound, systematic data is needed for policymakers to make intelligent policy choices, such as in the recent adoption of the DTSA, which was crafted largely based on anecdotes, guesswork, and unproven assumptions about the power and scope of trade secret law.

As such, the results of this study help fill a gaping void. In so doing, our study’s results shore up some initial empirical findings, confirm some theoretical views yet contradict others, and offer new possible routes for future scholarship and analysis. Our hope is that this Article inspires others to undertake this difficult but extremely important endeavor, and helps policymakers and the practicing bar understand the complex and shifting dynamics underlying trade secret law, and, more broadly, the reasons for limiting or expanding public access to information.

366 See Levine, supra note 44, at 147 n.43 (identifying one of the values of trade secrecy as the “public interest in having free competition in the sale and manufacture of goods not protected by a valid patent” (quoting Brunswick Corp. v. Outboard Marine Corp., 404 N.E.2d 205, 207 (Ill. 1980))).

367 See Lemley, supra note 31, at 315–16.

368 See supra Part II.

369 See Bill Donahue, 5 Things to Know About the Defend Trade Secrets Act, Law360 (Apr. 27, 2016), https://www.law360.com/ip/articles/789239 (quoting one of the authors (Levine) regarding the “dearth of empirical” data on trade secrets law, noting that policymakers “simply don’t know enough” about trade secrecy to enact the DTSA, and are effectively “throwing darts”).
2018] WHY DO STARTUPS USE TRADE SECRETS?  813

APPENDIX

FIGURE A1: REASONS NOT TO PATENT BASED ON PROCESS VS. PRODUCT INVENTIONS

For the same unpatented innovation, which if any of the following influenced your company’s decision not to patent?

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<thead>
<tr>
<th>Reason</th>
<th>Process</th>
<th>Product</th>
</tr>
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<tbody>
<tr>
<td>Did not want to disclose information</td>
<td>32.27%</td>
<td>41.04%</td>
</tr>
<tr>
<td>Cost of getting patent</td>
<td>54.01%</td>
<td>66.40%</td>
</tr>
<tr>
<td>Competitors could have invented around patent</td>
<td>47.64%</td>
<td>54.17%</td>
</tr>
<tr>
<td>Believed trade secret was adequate protection</td>
<td>34.13%</td>
<td>47.13%</td>
</tr>
<tr>
<td>Cost of enforcing patent</td>
<td>44.34%</td>
<td>52.00%</td>
</tr>
<tr>
<td>Believed technology was not patentable</td>
<td>37.74%</td>
<td>35.73%</td>
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<tr>
<td>No need for legal protection</td>
<td>15.57%</td>
<td>12.27%</td>
</tr>
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</table>

FIGURE A2: THE NUMBER OF PATENTS HELD VS. THE MOST IMPORTANT REASON NOT TO PATENT

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<tr>
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<th>Average Number of Patents Held</th>
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<td>Did not need legal protection</td>
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</tr>
<tr>
<td>Did not believe the technology was patentable</td>
<td>6.04</td>
</tr>
<tr>
<td>Cost of enforcing the patent, including actions in court, would have been too high</td>
<td>4.94</td>
</tr>
<tr>
<td>Trade secret protection was adequate</td>
<td>15.07</td>
</tr>
<tr>
<td>Competitors could have easily invented around the patent</td>
<td>13.80</td>
</tr>
<tr>
<td>Cost of getting the patent, including attorneys’ fees, would have been too high</td>
<td>7.91</td>
</tr>
<tr>
<td>Did not want to disclose information</td>
<td>23.55</td>
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Table A1: Model 1—Factors for Importance of Trade Secrecy

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2018] why do startups use trade secrets?  815

Table A2: Model 1—Average Marginal Effects of Factors for Importance of Trade Secrecy
(of each independent variable, holding others constant at their means)

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Table A3: Model 2—Factors for Importance of Trade Secrecy
Controlling for Industry

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Table A7: Factors for Importance of Patenting

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