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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* Jennings Professor and Associate Professor, Elon University School of Law; Affiliate Scholar, Center for Internet and Society at Stanford Law School.

** Professor, University of San Diego School of Law. The authors thank Jasmine Abdel-Khalik, Robert Brauneis, Brian Broughman, Michael Burstein, Victor Fleischer, Llew Gibbons, Eric Goldman, Michael Guttentag, Christine Hurt, Shawn Miller, Lateef Mtima, Christina Mulligan, Sean O'Connor, Michael Risch, Elizabeth Rosenblatt, Gordon Smith, Neel Sukhatme, and participants at conferences, presentations, and workshops at ESMT Berlin, New York University School of Law, Santa Clara University School of Law, Swinburne Law School, University of San Diego School of Law, and the University of Washington School of Law for their helpful comments and suggestions. We also thank Courtney Ball, Chris Genheimer, Dustin Gill, Danielle Hardy, Rebecca Kilmon, Marissa Lim, Moreen Mekha, Merima Mustafic, Poline Pourmorady, Kalie Chumley, Neil Rankin, Russell Romeo, Parth Sagdeo, Rachel Stariha, Bree Ward, and Millicent Whitemore for their invaluable research assistance.

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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

1 William Molinski & Jacob M. Heath, *Early Returns (Part 1 of 3): 3D Printing Company Sues Under New Defend Trade Secrets Act*, Orrick Blog: Trade Secrets Watch (June 22, 2016), https://blogs.orrick.com/trade-secrets-watch/2016/06/22/early-returns-part-1-of-2-3d-printing-company-sues-under-new-defend-trade-secrets-act/.

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.

3 David S. Almeling, *Tracking Trade Secret Stats*, Law360 (Mar. 25, 2010), https://www.law360.com/articles/156785/tracking-trade-secret-stats ("Trade secret cases doubled in the seven years from 1988 to 1995, and doubled again in the nine years from 1995 to 2004. At their current rate, trade secret cases will double again by 2017."); *see also* David S. Levine & Christopher B. Seaman, *The DTSA at One: An Empirical Study of the First Year of Litigation Under the Defend Trade Secrets Act*, 53 Wake Forest L. Rev. 105, 124–25 (2018) (finding 473 DTSA cases filed in federal courts from May 11, 2016, through May 11, 2017).

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

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.").

7 *See* Stuart J.H. Graham et al., *High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey*, 24 BERKELEY TECH. L.J. 1255, 1260, 1288 (2009).

8 Bronwyn Hall et al., The Choice Between Formal and Informal Intellectual Property: A Review 24 (March 2012) (unpublished draft) [hereinafter Hall et al., unpublished draft], http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.299.4184&rep=rep1&type=pdf. An updated version of the article was published two years later. Hall et al., *The Choice Between Formal and Informal Intellectual Property: A Review*, 52 J. ECON. LITERATURE 375, 384 (2014) [hereinafter Hall et al., *The Choice Between*].

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.[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."[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.[14] Second, trade secrets may act as both economic complements and substitutes to patenting.[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.[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).[17] Less prevalent are theories focused on startups.[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.[19] We focus on a startup's deci-

12 *See* discussion *infra* Part IV.

13 I.P.L. Png, Law and Innovation: Evidence from the Uniform Trade Secrets Act 28 (March 2011) (unpublished manuscript), http://www.fas.nus.edu.sg/ecs/events/seminar/seminar-papers/12Apr11.pdf.

14 *See* discussion *infra* Section IV.A.

15 *See* discussion *infra* Section IV.B.

16 *See* discussion *infra* Section IV.C.

17 *See* discussion *supra* Introduction (describing several prominent theories of why firms use trade secrets).

18 *See* discussion *infra* Sections I.A–B. (drawing primarily from studies focused on companies as a whole).

19 *See* discussion *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]

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.").

21 U.S. CONST. art. I, § 8, cl. 8.

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.").

23 *See* Robert G. Bone, *A New Look at Trade Secret Law: Doctrine in Search of Justification*, 86 CALIF. L. REV. 241, 247 (1998).

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).

26 *See generally* Mansi Shah, *Is Your Code Protected? Courts Everywhere Are Finding Software Patents Invalid, So What Next?*, MEDIUM: STARTUP (Aug. 28, 2015), https://medium.com/swlh/is-your-code-protected-70735e2e386 (discussing the invalidity of issued utility patents on computer software).

27 Timothy K. Sendek, *Customer Lists as Trade Secrets*, NAT'L L. REV. (Dec. 30, 2009), http://www.natlawreview.com/article/customer-lists-trade-secrets.

28 Geeta Daswani, Trade Secrets, Its Significance and a Comparative Analysis of Trade Secret Protection in Different Jurisdictions 3 (Nov. 15, 2016) (unpublished manuscript), https://ssrn.com/abstract=2869715 (mentioning Google's search algorithm as an example of a trade secret).

and other technical information.[29] Perhaps the most well-known example of the "best-kept trade secret[ ] in the world" is the recipe for Coca-Cola.[30]

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.[31] Although startups can maintain a lead-time advantage simply because of the inherent failure of competitors to innovate,[32] 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.[33] 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.[34]

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

29 Allen Dixon, *Leading Practices to Protect Trade Secrets*, WOLTERS KLUWER: KLUWER PAT. BLOG (Nov. 1, 2016), http://kluwerpatentblog.com/2016/11/01/leading-practices-to-protect-trade-secrets.

30 Coca-Cola Bottling Co. of Shreveport v. Coca-Cola Co., 107 F.R.D. 288, 289 (D. Del. 1985).

31 *See* NATHAN WAJSMAN & FRANCISCO GARCÍA-VALERO, EUR. UNION INTELLECTUAL PROP. OFFICE, PROTECTING INNOVATION THROUGH TRADE SECRETS AND PATENTS: DETERMINANTS FOR EUROPEAN UNION FIRMS 11 (2017) ("'Lead time advantage' is the practice to commercialise an innovation as fast as possible to benefit from so-called first-mover advantages."); Mark A. Lemley, *The Surprising Virtues of Treating Trade Secrets as IP Rights*, 61 STAN. L. REV. 311, 330 (2008) ("[P]rotection for business ideas helps ensure a first-mover advantage for those who take risks on untested business models."); Michael Risch, *Why Do We Have Trade Secrets?*, 11 MARQ. INTELL. PROP. L. REV. 1, 22 (2007) ("[T]he value of a secret process lies in its exclusivity; the ability of one person to use information and to keep others from using it is exactly what gives the information a competitive advantage.").

32 *See* Anthony Arundel, *The Relative Effectiveness of Patents and Secrecy for Appropriation*, 30 RES. POL'Y 611, 615 (2001) (surveying 2849 R&D performing firms and finding that lead time is far more important than secrecy and patents).

33 *See* Francesco Castellaneta et al., *Money Secrets: How Does Trade Secret Legal Protection Affect Firm Market Value? Evidence from the Uniform Trade Secret Act*, 38 STRATEGIC MGMT. J. 834, 836 (2017) ("In today's knowledge-based economy, competitive advantage depends more and more on firms having and protecting valuable and rare proprietary information, unknown to rivals."); Pia Hurmelinna-Laukkanen & Kaisu Puumalainen, *Nature and Dynamics of Appropriability: Strategies for Appropriating Returns on Innovation*, 37 R&D MGMT. 95, 106 (2007) (finding a positive relationship between seeking short-term value, the use of lead time, and secrecy).

34 *See* WAJSMAN & GARCÍA-VALERO, *supra* note 31, at 28 ("[T]he top three [protection] mechanisms reported in most [EU] countries are first-mover advantages, complexity of product and secrecy."); Brenda M. Simon & Ted Sichelman, *Data-Generating Patents*, 111 NW. U. L. REV. 377, 382 (2017) ("Google's use of its aggregated search data derived from its patented search algorithms is . . . used to target customized advertising to users . . . to improve the algorithms per se.").

extend the lead.[35] 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.[36]

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.[37] 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.[38]

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.[39] 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 patenta-

35 *See* Alexandra K. Zaby, *Losing the Lead: The Patenting Decision in the Light of the Disclosure Requirement*, 19 ECON. INNOVATION & NEW TECH. 147, 149 (2010) ("[If] the winner of one R&D race decides to patent his invention, he loses his technological lead and consequently all firms face the same probability of success subsequently."); *cf.* Klaus Kultti et al., *Secrecy Versus Patenting*, 38 RAND J. ECON. 22, 23 (2007) (arguing that innovators more often are choosing not between secrecy and patenting, but between patenting and letting the competition patent). *See generally* Michael Risch, *Trade Secret Law and Information Development Incentives*, *in* THE LAW AND THEORY OF TRADE SECRECY 152 (Rochelle C. Dreyfuss & Katherine J. Strandburg eds., 2011) (discussing the role of trade secrecy in the context of other intellectual property rights).

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* WAJSMAN & GARCÍA-VALERO, *supra* note 31, at 10 ("[E]ntrepreneurs 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. 167, 2014) ("A further incentivising effect noted in the literature is the role that trade secrets may play in conferring competitive benefits. . . . [F]irms 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]

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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/iprenforcement/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-Álvarez & 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

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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.").

48 *See* Ryan Davis, *Wave of USPTO* Alice *Rejections Has Cos. Tweaking Strategies*, LAW360 (Nov. 2, 2015), http://www.law360.com/articles/720762/wave-of-uspto-alice-rejections-has-cos-tweaking-strategies (quoting Brian Emfinger, who said that "Alice really changed the game and set the bar and the standard much higher"); Seth Northrop, *Software and Trade Secrets: Rethinking IP Strategies After* CLS v. Alice, JDSUPRA (June 30, 2014), https://www.jdsupra.com/legalnews/software-and-trade-secrets-rethinking-i-15738/ ("As a result [of the Supreme Court's decision in *Alice Corp. v. CLS Bank International*], software innovators may find that, in some cases, trade secret law now offers the best method for protecting proprietary software advancements.").

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/eyJpZCI6IkEwSDhXNlc0UDc/anM9MCZzdWJzY3JpcHRpb250eXBlPWJuYXB0ZCZpc3N1ZT0yMDE2MDIxMCZjYW1wYWlnb ("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,[52] covering business plans, customer lists, so-called "negative know-how," and certainly software[53] and biotechnology inventions.[54]

The America Invents Act (AIA) is another substantive change in patent law that potentially makes trade secrecy more attractive.[55] 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.[56] 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.[57]

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."[58] Obtaining and asserting patents is expensive,[59]

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52 *See* WAJSMAN & GARCÍA-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.").

53 *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%)).

54 *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 & GARCÍA-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.").

55 *See* Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (codified as amended in scattered sections of 35 U.S.C.) (enacting amendments to the Patent Act that are favorable to trade secret holders); Edward D. Manzo, *The Impact of the America Invents Act on Trade Secrets,* 13 J. MARSHALL REV. INTELL. PROP. L. 497, 501 (2014) ("[O]ne must now ask whether the AIA changed the balance between trade secret law and patent law and what the new relationship will be between these different approaches to protecting technology.").

56 *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.").

57 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).

58 Ted Sichelman & Stuart J.H. Graham, *Patenting by Entrepreneurs: An Empirical Study*, 17 MICH. TELECOMM. & TECH. L. REV. 111, 117 (2010); *see also* WAJSMAN & GARCÍA-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).

59 *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]

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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 ("[Trade 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 DENV. 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.").

65 *See USPTO Fee Schedule*, U.S. PATENT & TRADEMARK OFFICE, https://www.uspto.gov/learning-and-resources/fees-and-payment/uspto-fee-schedule#Patent%20Maintenance%20Fee (last updated Oct. 1, 2018).

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."[70] 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.[71] 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."[72]

Patents are simply not an adequate substitute for startups that do not have the same financial backing as larger, more established firms.[73] Thus, it has been argued that an important goal of trade secrecy is, paradoxically, for "businesses to spend less money protecting secret information."[74] Professor Michael Risch argues that "[b]y allowing the creator exclusive use, the creator can more readily recoup [the] cost[ ] of creation."[75]

4. To Provide Protection Prior to and Complementary with Patenting

Although patents and trade secrets are often considered mutually exclusive substitutes,[76] they are often used as complementary[77] strategies, espe-

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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* WAJSMAN & 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 ("[There is an] interplay between control and execution as alternative routes to appropriability.").

cially for large portfolios of intellectual property.[78] First, a strong trade secret protection program is often important during the "early stages of development . . . [to] protect information that offers a competitive advantage."[79] 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.[80]

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.[81] 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*.[82] 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.[83] Thus, startups must invest in robust protection programs.

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77 *See* WAJSMAN & 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).

79 Esmond et al., *supra* note 49, at 4.

80 *See id.* (positing important questions for firms to address when deciding to file for patent protection); *see also* WAJSMAN & 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 . . . ."); WAJSMAN & 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 larger 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 Hedge, *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

Similarly, trade secrecy can work in tandem with existing patents.[84] For instance, IP and lead time can be complementary,[85] and startups may "protect innovations by concentrating on safeguarding innovative input, rather than innovations as output."[86] 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.[87] 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.[88]

Moreover, even for pure product patents, it is often possible in practice to withhold key details of the invention, yet still obtain patent protection.[89] Related, a firm may improve an existing patented invention, maintaining the improvement as a trade secret.[90] 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* WAJSMAN & GARCÍA-VALERO, *supra* note 31, at 14 ("[Trade secrets] may be used in combination with other IP protection mechanisms to protect complex innovations . . . .").

85 *See* WAJSMAN & GARCÍA-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* WAJSMAN & GARCÍA-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* WAJSMAN & GARCÍA-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 & Sichelman, *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.[91] 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.[92] 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.[93]

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.[94] 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.[95] 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.[96] 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.[97] 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.[98] 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

91 *See, e.g.*, Simon & Sichelman, *supra* note 34, at 383 ("[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 a 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.[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.[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.[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.[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."[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.[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.[105] Specifically, if an

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.").

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.").

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.").

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).

103 WAJSMAN & GARCÍA-VALERO, *supra* note 31, at 15 ("[Trade secrets] require explicit non-disclosure and not-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 ARIZ. L. REV. 939, 940 (2012) (defining "noncompetition 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).

104 *See* Jonathan M. Barnett & Ted M. Sichelman, *Revisiting Labor Mobility in Innovation Markets* (USC Law Legal Studies Research Papers Series No. 16-15, 2016), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2758854 ("[S]everal state legislatures have enacted laws or are considering enacting laws to prohibit or restrict noncompetes.").

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.[106] Thus, although there is some debate about whether patents or trade secrets are more effective in this role,[107] 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).[108]

7. To Generate Licensing Revenues

Typically, licensing of technological inventions occurs via the licensing of patents.[109] 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.[110] 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.[111] Either the prospective licensee pays for its use via a license, or in the event the licensee uses the invention without authorization,

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 ("[I]n 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."), *with* Vincenzo Denicolò & Luigi Alberto Franzoni, *Patents, Secrets, and the First-Inventor Defense*, 13 J. ECON. & MGMT. STRATEGY 517, 537 (2004) ("[C]ertain industries—for instances, those in which the risk of leakage is lowest—prefer to rely on secrecy.").

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.").

110 *See generally* Yuichi Watanabe, Comment, *Patent Licensing and the Emergence of a New Patent Market*, 9 HOUS. BUS. & TAX L.J. 445, 463–64 (2009) (explaining that the patentee can forgo the exclusivity to make, use, and sell the invention in the patent in exchange for a license fee).

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-

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 ("[Information] 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.[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.[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.[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.[122] Indeed, consistent with such a view, one scholar theorizes that knowledge leakage decreases bargaining power and increases new competitors.[123]

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.[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-

119 *See id.* at 235 (discussing how information-flow design overcomes the disclosure paradox).

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).

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.").

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.").

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).

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.").

neering, then patents may be preferable.[125] 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.[126]

To a large degree, the ease with which reverse engineering may be achieved depends on the complexity of the underlying information.[127] For instance, in software, a skilled programmer can often view a product's functionality and design it.[128] On the other hand, code itself is more difficult, and in some cases impossible, to reverse engineer, making trade secrecy a more attractive option.[129] 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.[130] In sum, to the extent that any putative trade secret could be reverse engineered, trade secrecy should be cautiously used.[131]

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

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.[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.[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.[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."[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."[136] In this regard, more competition naturally means more risk of being patented out of existence.[137] Thus, despite the high costs to patenting, the risk of complete or even partial loss may be a powerful incentive to patent.[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.[139]

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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.").

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.").

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.").

135 Lee Davis, *Intellectual Property Rights, Strategy and Policy*, 13 ECON. INNOVATION & NEW TECH. 399, 408 (2004).

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.").

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/altri-atti-seminari/2012/Hall.pdf ("[F]irms in more competitive sectors . . . tend to use more legal IP methods (i.e. patents and trade marks).").

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).

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).[140] Trade secrecy typically does not attract venture capitalists and other investors who may refuse to sign confidentiality agreements.[141] 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.[142]

Patents may allow for better signaling to investors, and thus may be more valuable to inexperienced innovators.[143] 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.[144] 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 Neuhäusler, *The Use of Patents and Informal Appropriation Mechanisms—Differences Between Sectors and Among Companies*, 32 TECHNOVATION 681, 684 (2012) ("[P]atents 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 . . . .").

144 *See, e.g.*, Andrew Beckerman-Rodau, *The Choice Between Patent Protection and Trade Secret Protection: A Legal and Business Decision*, 84 J. PAT. & TRADEMARK OFF. SOC'Y 371, 402 (2002) ("[L]oss of a trade secret may not financially devastate some enterprises. For some products, being first in the marketplace provides a significant economic advantage over competitors.").

are publicly traded.[145] 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.[146]

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.[147] 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.[148]

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-

145 *See* Nishant Dass et al., Intellectual Property Protection and Financial Markets: Patenting vs. Secrecy 3 (July 25, 2015) (unpublished manuscript), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2517838 ("The opacity that results from a greater reliance on secrecy could reduce the extent to which the firm is followed by analysts and held by institutional investors.").

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."); Megan Ristau Baca, Book Note, *The Wealth of Networks: How Social Production Transforms Markets and Freedom*, 20 HARV. J.L. & TECH. 271, 277 (2006) ("Benkler hails the success of free software as critical to the recognition of the peer production model as a viable alternative to industrial production."); Heather R. Pruger & Adam S. Zarren, *Open Source Software: Buyer Beware of Custom Development and M&A Transaction Risks*, MD. B.J., Nov. 2014, at 22, 24 ("Open source software can be easier to manage than proprietary third-party software, as open source products do not require location- or machine-specific counting, tracking, or monitoring, whereas proprietary third-party software products are often licensed on a per-instance basis and require close monitoring.").

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.").

nerships with "over 150 companies."[149] 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."[150] 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.[151]

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.[152] 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.[153] Technically, contracting with employees does not preclude use of trade secrets as a complementary form of protection.[154] In this sense, contract and trade

149 Marketwired, *Open-Silicon Unveils Industry's Highest Performance Interlaken Chip-to-Chip Interface IP*, YAHOO! FIN. (Apr. 4, 2017), https://finance.yahoo.com/news/open-silicon-unveils-industrys-highest-120000246.html.

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 intellectual 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. INTELL. 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.").

154 *See Trade Secret Litigation and Confidentiality Agreements*, HINCH NEWMAN LLP, http://www.hinchnewman.com/practice-areas/internet-law/trade-secret-agreements-confidentiality-non-compete-social-media-policies/ (last visited Sept. 18, 2018) ("Confidentiality agreements serve to protect company trade secrets, intellectual property, and other proprietary information.").

secrecy are not always substitutes.[155] Indeed, noncompete agreements can bolster baseline trade secret protection, making it even more difficult for an employee to depart for a competitor.[156] 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.[157]

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.[158] This "gap in the [empirical] literature" on "alternatives to the patent system for appropriating innovative results" like "industrial secret[s]"[159] 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* Wajsman & 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.

159 Jesús Galende, *The Appropriation of the Results of Innovative Activity*, 35 Int'l J. Tech. Mgmt. 107, 108, 111 fig.1 (2006); *see also* Stuart J.H. Graham, *Hiding in the Patent's Shadow: Firms' Uses of Secrecy to Capture Value from New Discoveries* 30 (GaTech TI:GER Working Paper Series, 2004), https://smartech.gatech.edu/bitstream/handle/1853/10725/gt_tiger_hiding.pdf?sequence=1&isAllowed=Y ("Secrecy, long known to be the most effective method of capturing value from discoveries, has heretofore been hidden from us.").

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."[160]

Of course, there is a good reason for the dearth of literature: "[C]ompanies' use of [trade] secrecy" is "unobserv[able]."[161] Nonetheless, there have been a few broad empirical studies, though many of the leading studies in the field are dated.[162] For instance, Professor Bronwyn Hall recently reviewed the existing trade secret empirical literature and noted that the "seminal studies"[163] in the field remain the Levin et al. study from 1987[164] and the Cohen et al. study from 2000.[165]

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[166] and the Defend Trade

160 Michael Risch, *Empirical Methods in Trade Secret Research*, *in* 2 RESEARCH HANDBOOK ON THE ECONOMICS OF INTELLECTUAL PROPERTY LAW 1 (Peter S. Menell & David L. Schwartz eds., forthcoming 2019). The EC's comprehensive 2013 survey of existing trade secret literature noted the almost complete absence of nonmanufacturing entities in existing datasets, a significant weakness. *See* EUR. COMM'N, *Study on Trade Secrets*, *supra* note 41, at 97. Png explained in 2011 that "[d]espite the practical importance of trade secrecy to innovation, there has been little empirical research into the [economic] impact of trade secrets . . . ." Png, *supra* note 13, at 2.

161 Hall et al., *The Choice Between*, *supra* note 8, at 410 (noting the "empirical difficulty of observing the use of [trade] secrecy as an appropriation mechanism"); *see also* David S. Almeling et al., *A Statistical Analysis of Trade Secret Litigation in Federal Courts*, 45 GONZ. L. REV. 291, 292 (2009); Lippoldt & Schultz, *supra* note 38, at 10.

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).

163 Hall & Sena, *supra* note 137, at 5 ("The seminal studies in [intellectual property empirical literature] are those by Levin *et al.* (1987)—so called Yale I survey—and Cohen *et al.* (2000)—the Carnegie Mellon survey.").

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).

166 *See Trade Secrets*, EUR. COMM'N, http://ec.europa.eu/growth/industry/intellectual-property/trade-secrets/index_en.htm (last updated Aug. 11, 2018) [hereinafter EUR.

Secrets Act (DTSA) in the United States.[167] Specifically, the EU Trade Secret Directive, adopted on June 8, 2016,[168] "aims to standardise the national laws in EU countries against the unlawful acquisition, disclosure and use of trade secrets."[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.[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)).[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."[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.[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

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COMM'N, *Trade Secrets*] (stating that the Trade Secret Directive "aims to standardise the national laws in EU countries against the unlawful acquisition, disclosure and use of trade secrets").

167 *See* Defend Trade Secrets Act of 2016, Pub. L. No. 114-153, § 5, 130 Stat. 376, 384 (noting that the Act "applies broadly to protect trade secrets from theft").

168 *See* Directive 2016/943, of the European Parliament and of the Council of 8 June 2016 on the Protection of Undisclosed Know-How and Business Information (Trade Secrets) Against Their Unlawful Acquisition, Use and Disclosure, 2016 O.J. (L 157). The Directive requires EU countries to bring into force the laws and administrative provisions necessary to comply with the Directive by June 9, 2018. *See id.* at art. 19, para. 1 ("Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive by 9 June 2018.").

169 EUR. COMM'N, *Trade Secrets*, *supra* note 166.

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."); *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).

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).

172 *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. *Id.*

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. *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/dthe9spk32t5q331rl0hck9duor6.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.[179] Surveys of eight Finnish SMEs, including IT firms, found that secrecy was the most popular appropriation method, ahead of IP and contracts.[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).[181] Naturally, these surveys also confirm the corollary that large firms benefit more from patents.[182] There is also little reported variance between process- and product-focused firms.[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.[184] The most common response (79%) was not to resort to patents as a means of protecting against leakage,[185] but rather to build "[t]rust relationships that ensure specialist knowledge is not stolen,"[186] which is at the heart of "reasonable efforts" in trade secrecy.[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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ferred to allocate resources to the development of new product and process innovations."). Olander notes the SME's challenge of simultaneously having to share knowledge with partners but lacking resources to use "expensive and complex protection mechanisms." Olander et al., *supra* note 82, at 364 ("The limited resources of SMEs simultaneously create (1) the need to disclose their knowledge to varying partners, and (2) impediments to using expensive and complex protection mechanisms.").

179 *See* Arundel, *supra* note 32, at 614 ("Several additional factors, such as the types of information sources used by the firm, also influence the relative importance of secrecy vs. patents.").

180 *See* Olander et al., *supra* note 82, at 361–62 ("[O]btaining IPRs, with the exception of copyright, is often difficult, whereas informal protection mechanisms (e.g. secrecy) are more readily at the SMEs' disposal.")

181 *See* Leiponen & Byma, *supra* note 59, at 1482 ("Complementary products are the most commonly used strategy for innovating firms . . . followed by speed to market . . . and secrecy . . . .").

182 *See* Gallié & Legros, *supra* note 107, at 787; Helmers & Rogers, *supra* note 42, at 1018; *id.* at 1479 (reviewing literature); *see also* Dass et al., *supra* note 145, at 4 (noting SMEs, based on total assets or market share, reduce patents after enactment of trade secret statutes, and stock liquidity diminishes).

183 EUR. COMM'N, *Study on Trade Secrets*, *supra* note 41, at 103 tbl.3.

184 *See, e.g.*, Kitching & Blackburn, *supra* note 178, at 329.

185 *Id.* at 332. This question was not asked in this context, but 23.6% of entities overall indicated that they utilized patents. *See id.* at 330.

186 *Id.* at 332 tbl.3.

187 *See* Dass et al., *supra* note 145, at 9–10 (noting that one of the six items that characterize the three aspects of trade secrets is whether the owner must take reasonable efforts to protect the secret); *see also* STEWART S. MANELA ET AL., EMPLOYEE DUTY OF LOYALTY: A STATE-BY-STATE SURVEY 1 (1995) (stating that "[t]he employment relationship is one of

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 Gallié & 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 Brant & Sebastian Lohse, 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."[193]

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.[194] 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).[195] 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.[196]

2. Products vs. Processes

The literature also draws a meaningful distinction between innovative processes and innovative products.[197] Generally, studies have shown that secrecy and lead-time are more important means than patents when protecting process innovations against duplication and competition.[198] 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

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Trade Secrets Act, Defend Trade Secrets Act, and the Economic Espionage Act. *See id.* at 377 ("[I]n most common law countries, including the United Kingdom and the United States, trade secret law forms part of the common law . . . ."); Economic Espionage Act of 1996, 18 U.S.C. § 1831 (2012); Defend Trade Secrets Act of 2016, Pub. L. No. 114-153, 130 Stat. 376 (codified in scattered sections of 18 U.S.C.); UNIF. TRADE SECRETS ACT (UNIF. LAW COMM'N 1985).

193 Hall et al., *The Choice Between*, *supra* note 8, at 378.

194 Perhaps related to that point, the authors in Hall et al, *The Choice Between*, *supra* note 8, note that the "'informal' label does not imply the absence of legal contracts and obligations." *Id.* at 378 n.9.

195 *See* Cohen et al., *supra* note 165, at 10 ("Secrecy is now clearly the most effective mechanism[ ] in [the] aggregate . . . ."); Hall et al., *The Choice Between*, *supra* note 8, at 378 ("The evidence available from various firm-level surveys . . . suggests that on average, firms rely more on informal than formal IP to protect their inventions, and that most firms use no IP protection at all."); Leiponen & Byma, *supra* note 59, at 1478 ("Most of the small firms examined here find informal means of protection, such as speed to market or secrecy, more important than patenting.").

196 *See supra* Section I.A (discussing how startups and small firms may be subjected to high costs in the process of obtaining a patent; however, trade secrets are not granted the exclusive rights that patents are).

197 *See, e.g.*, Hall et al., *The Choice Between*, *supra* note 8, at 405 (noting that "[p]roduct innovations are more likely to represent patentable subject matter" meaning that there is less uncertainty and that "[p]atents on process innovations may also reveal more information than patents on products").

198 *See id.* at 380 ("On average, patents are not the most important mechanism of IP appropriation, while secrecy and lead time are . . . .").

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 & Puumalainen, *supra* note 33, 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.

202 Patrick Keating, *"Lead Time" Injunctions*, PATRICK KEATING (Oct. 24, 2015), http://pkeating.com/?p=393.

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. 535, 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 know-how 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.*

216 *See* Luis Diestre & Nandini Rajagopalan, *Are All 'Sharks' Dangerous? New Biotechnology Ventures and Partner Selection in R&D Alliances*, 33 STRATEGIC MGMT. J. 1115, 1132 (2012); Riitta Katila et al., *Swimming with Sharks: Technology Ventures, Defense Mechanisms and Corporate Relationships*, 53 ADMIN. SCI. Q. 295, 316 (2008).

217 *See* Talhiya Sheikh, *Trade Secrets and Employee Loyalty*, WORLD INTELL. PROP. ORG., http://www.wipo.int/sme/en/documents/trade_secrets_employee_loyalty.html (last visited Aug. 20, 2017).

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.

220 *See* Henry R. Hertzfeld et al., *Intellectual Property Protection Mechanisms in Research Partnerships*, 35 RES. POL'Y 825, 826 (2006).

221 Galende, *supra* note 159, at 110.

222 *See* González-Álvarez & Nieto-Antolín, *supra* note 43, at 284; Hurmelinna-Laukkanen & Puumalainen, *supra* note 33.

223 *See* Stuart J.H. Graham & Ted Sichelman, *Why Do Start-Ups Patent?*, 23 BERKELEY TECH. L.J. 1063, 1088 (2008) ("[A] patentee may often be able to patent an invention and keep its 'secret sauce' a trade secret.").

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.

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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.

230 *See* I.P.L. Png, Law and Innovation: Evidence from the Uniform Trade Secrets Act 3 (Aug. 2011) (unpublished manuscript), https://nanopdf.com/download/law-and-innovation-evidence-from-the-uniform-trade-secrets-act-ipl-png_pdf ("The impact of the UTSA [on R&D expenditures] was quite nuanced, being significant among low-tech companies, but not significant among high-tech companies.").

231 *See* Png, *supra* note 13, at 19.

232 *See* WAJSMAN & GARCÍA-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.[236] 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.[237] As Png notes, most analytical studies treat trade secrets and patents as substitutes.[238] He explains the basic assumed structure as "[f]irst, the innovator decides on R&D, then, the innovator chooses between patents and secrecy, and finally, the innovator engages with possible competitors."[239]

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."[240]

A study of 250 large, diversified U.S. companies involved in research partnerships is a good example of this trend.[241] 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,"[242] but patents were still ahead of trade secrecy to protect "existing technology (background knowledge)."[243]

Nonetheless, the result of little empirical data is a fair amount of theorizing and educated guessing, although not focused on startups.[244] Thus, Hall and her coauthors have suggested that researchers should take a closer look at patents and trade secrets as complements rather than substitutes.[245] 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.[246] 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.[247] Second, whether patents, as well as other forms of IP, and trade secrets can act as economic complements.[248] 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.[249]

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.[250] 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.[251]

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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 II.A (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, we[253] 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.").

ing trade secrets.[259] 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.[260] The survey then asked which of these appropriability mechanisms was the most important. Specifically, the questions were as follows[261]:

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

	Very Important	Moderately Important	Slightly Important	Not Important At All
a. First-mover advantage over competitors	□	□	□	□
b. Secrecy	□	□	□	□
b. Patents	□	□	□	□
c. Copyright	□	□	□	□
d. Trademarks	□	□	□	□
e. Difficulty of reverse engineering	□	□	□	□
f. Other production, implementation, or marketing capabilities deployed along with the innovation	□	□	□	□

Second, the survey inquired about the reasons for not patenting an innovation, including whether the company "did not want to disclose information."[262] Specifically, the survey asked the following questions[263]:

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 adquate protection	☐
e. Cost of enforcing the patent, including actions in court	☐
f. Did not believe the technoloy 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]

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.[267] 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.[268] 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.[269] Generally, any differences in these characteristics are not statistically significant at conventional levels.[270] 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.[271] 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.[272] 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.[273]

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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."[274] Indeed, no previous survey recounted earlier examined characteristics of their respondent sample against their nonrespondent sample.[275] 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.[276]

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).[277] 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.[278] 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.[279] 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.[280] Given these findings, we do not view the differences in background characteristics reported above as problematic.[281]

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.[282] 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]

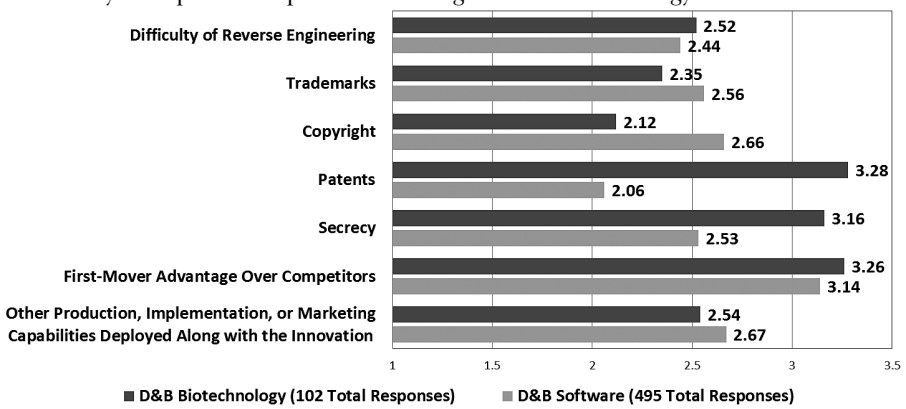
1. Descriptive Results

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
(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,

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.[289] Thus, for startup biomedical companies, the importance of secrecy to capture competitive advantage was paramount.[290]

Within the software industry, however, secrecy was significantly less important than first-mover advantage, copyright, and other production, implementation, or marketing capabilities.[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.[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.[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.[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.[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.[296] Thus, network effects, branding, client relationships, and other barriers to entry must play stronger roles than patents or

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.").

290 *Cf. id.* at 1291 & n.113 ("For this group of firms, patenting is ranked as the most important means of capturing competitive advantage.").

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).

292 This difference is significant at a 99% confidence level.

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 . . . .").

294 *See infra* Appendix, Figure A1. These differences are statistically significant at a 99% confidence level.

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) ("[I]t is not possible to reverse-engineer genetic code (as it is computer software) through the use of instructions . . . .").

296 *See supra* Figure 1.

trade secrecy in cementing first-mover advantage for software startups.[297] 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.

297 *See* Borden, Inc., 92 F.T.C. 699, 830 (1978) (Pitofsky, Comm'r, concurring) (contending that "pronounced consumer brand loyalty is a barrier to entry"); Mark A. Lemley & David McGowan, *Legal Implications of Network Economic Effects*, 86 CALIF. L. REV. 479, 491 (1998) (noting that "[c]omputer software is the paradigm example" of a "virtual" network effect).

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.

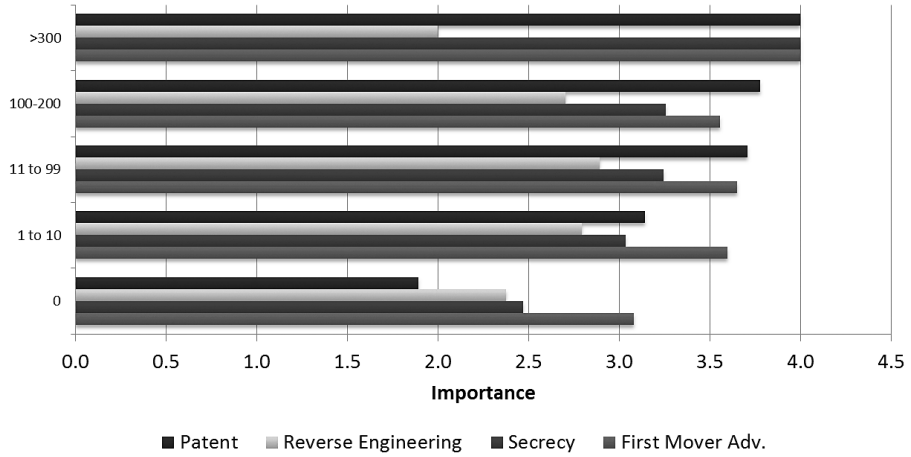
300 Graham et al., *supra* note 7, at 1290–92 ("[I]n the 1994 Carnegie-Mellon Survey, IT hardware firms (such as semiconductors and communications equipment) reported that patenting was only effective at protecting about one-quarter of their product innovations, compared with secrecy, which was effective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

FIGURE 2: APPROPRIABILITY MECHANISMS BY NUMBER OF PATENTS



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 a complements, at least for companies that hold many patents. Further supporting this view, in Figure A1

304 This difference is significant at a 99% confidence level.

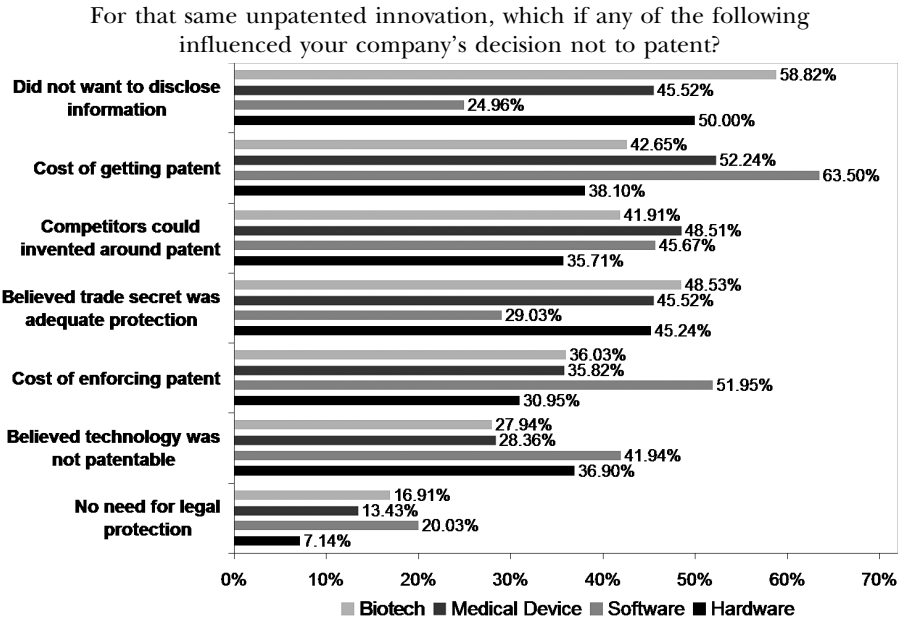
305 For respondents with no patents, the difference between the average importance of secrecy and the average importance of first-mover advantage is statistically significant at a 99% confidence level. Therefore, for respondents with no patents, there is no statistically significant difference in importance between secrecy and the importance of the difficulty in reverse engineering.

306 For respondents with 100 to 200 patents, the difference between the average importance of secrecy and the average importance of patents, and the difference between the average importance of secrecy and the average importance of the difficulty of reverse engineering are statistically significant at a 99% confidence level.

307 *See supra* Figure 2 (showing these results).

(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]

FIGURE 3: 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 secre[cy] was adequate protection" and they "did not want to disclose information" in a

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.

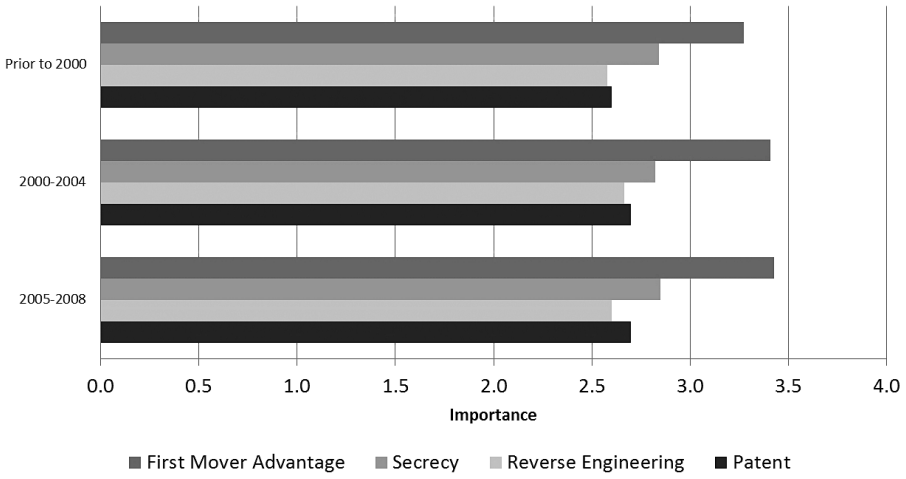
patent. Specifically, roughly 45–48% of companies in the biotechnology, medical device, and IT hardware industries, and 29% of software companies, reported that trade secrecy was adequate. Nearly 59% of biotech companies reported that they did not patent a previous invention because they did not want 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 (positing patents and trade secrets as both substitutes and complements).

314 *See supra* subsection II.B.4.

315 *See infra* Figure 4.

regardless of their age group.[316] 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.[317] 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.[318] 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.[319] 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.[320]

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).[321] 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.[322]

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

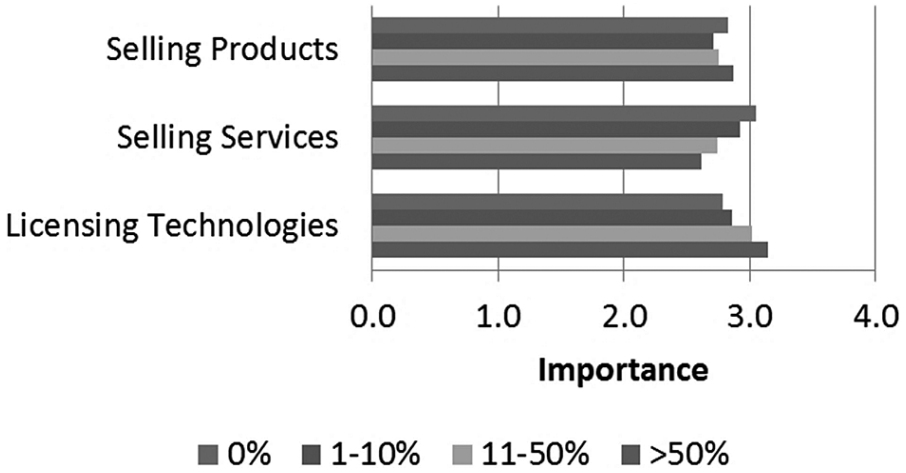


Figure 5 shows the relationship between the proportion of revenue a company derives from each of three sources—selling products, selling services, and licensing technologies—and the corresponding importance such companies give to secrecy as an appropriability mechanism. Of companies deriving a majority 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.[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.[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.[328]

2. Regression Models

Here, in order to pinpoint the drivers of trade secrecy usage and effectiveness, we employ multivariate ordered logistic regression techniques.[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.[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.

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326 The *p*-value for this difference is approximately 0.64.

327 The *p*-value for this difference is approximately 0.64.

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.

329 We thank Shawn P. Miller, Intellectual Property Research Fellow at Stanford Law School, for his assistance in performing the regressions.

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, *Regression Models for Ordinal Data*, 42 J. ROYAL STAT. SOC'Y. 109 (1980).

TABLE 1: LIST OF EXPLANATORY AND SURVEY RESPONSE VARIABLES

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

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

Field Name	**Coeff**[332]
patents	0.55***
firstmover	0.56***
reverseeng	0.36***
strategyprod	0.15
trademarks	-0.00
complementassets	0.23***
copyright	0.07
strategydesign	0.13*
strategyprocess	0.34***
shareeng	0.32
strategymodel	-0.13
employs	0.001
evenue	1.9e-7
agein2008	0.026
sellservice	-0.22
sellprod	-0.43*

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

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

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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.[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.[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.[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.[340]

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.

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.").

339 *See supra* notes 45–54 and accompanying text.

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

Field Name	**Coeff**
secrecy	0.69***
firstmover	0.27***
reverseeng	0.25***
strategyprod	0.49***
trademarks	0.45***
complementassets	-0.13
copyright	-0.08
strategydesign	0.008
strategyprocess	0.017
shareeng	0.59**
strategymodel	-0.01
employs	0.00
revenue	-1.8e-7
agein2008	-0.017
sellservice	-2.40***
sellprod	-1.36***

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.[341] Our results provide mixed support for this theoretical observation. For biotechnology startups, secrecy, patents, and first-mover advantage were indistinguishable statistically.[342] 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.[343]

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.[344] 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.[345] Yet, as noted earlier, continuous advancement over competitors, network effects, branding benefits, and other barriers to entry can lead to similar lead-time advantages.[346] 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.[347]

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.[348] 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.[349]

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341 *See supra* subsection I.A.1.

342 *See supra* subsection I.A.1.

343 *See supra* notes 204–06 and accompanying text.

344 *See supra* Figure 1.

345 *See* Hurmelinna-Laukkanen & Puumalainen, *supra* note 33, at 103.

346 *See supra* subsection II.B.3.

347 *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).

348 *See supra* note 147 and accompanying text.

349 *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 nonpatented 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]

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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.[366] One key pillar of intellectual property law today is the law of trade secrecy.[367] Yet, oddly, very little empirical research has focused on the usage and effectiveness of trade secrecy for startups.[368] 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.[369]

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").

Appendix

Figure A1: Reasons Not to Patent Based on Process vs. Product Inventions

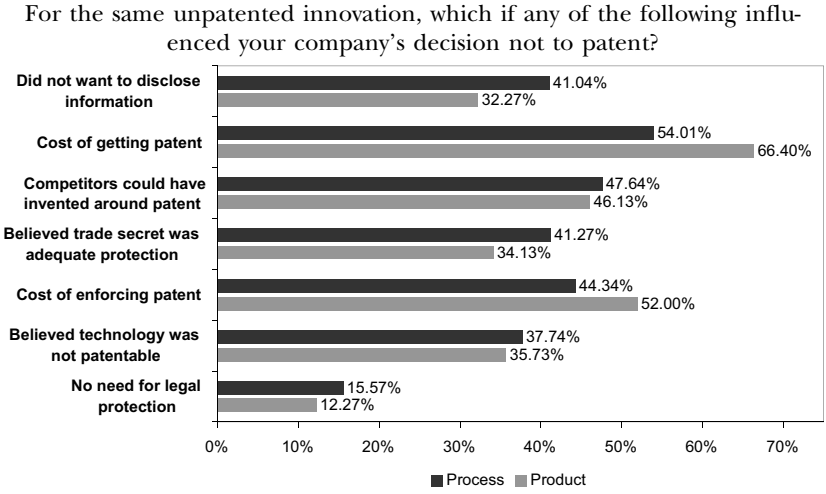

Figure A2: The Number of Patents Held vs. the Most Important Reason Not to Patent

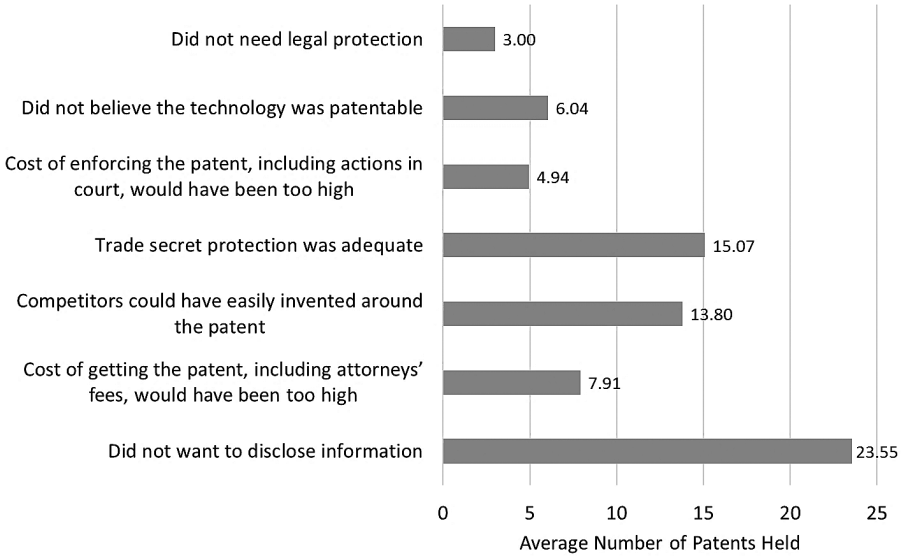

FIGURE A3: NUMBER OF EMPLOYEES VS. IMPORTANCE OF APPROPRIABILITY MECHANISMS

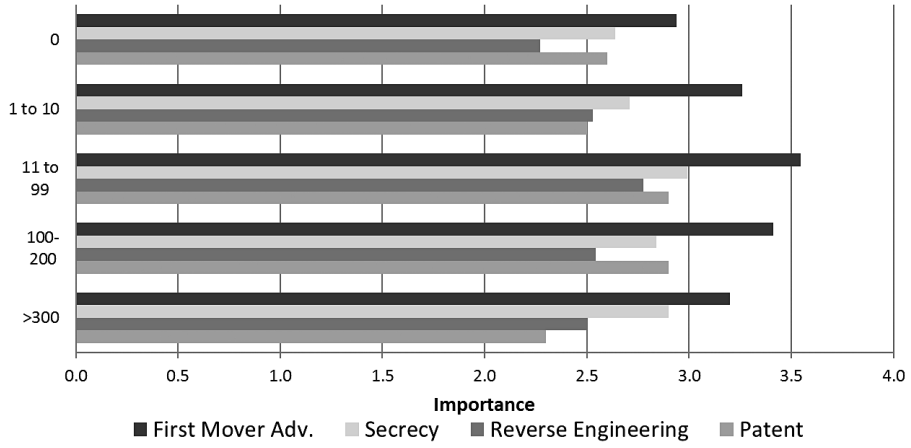

TABLE A1: MODEL 1—FACTORS FOR IMPORTANCE OF TRADE SECRECY

	1	2	3	4	5	6
patents	0.56***	0.59***	0.73***	0.58***	0.55***	0.55***
firstmover	0.59***	0.66***	0.60***	0.57***	0.57***	0.56***
reverseeng	0.35***	0.35***	0.25***	0.31***	0.40***	0.36***
strategyprod	0.16	0.03	-0.05	0.18	0.13	0.15
trademarks	0.06	0.20	0.03	0.05	0.02	-0.00
Complement-assets	0.20***	0.23**	0.30***	0.18**	0.21**	0.23***
copyright	0.06	-0.17	0.04	0.04	0.07	0.07
strategydesign	0.06	0.03	0.17**	0.07	0.14**	0.13*
strategyprocess	0.23***	0.32***	0.36***	0.21**	0.30***	0.34***
shareeng	0.53***	1.01***	0.47*	0.50**	0.36	0.32
strategymodel	-0.10	-0.08	-0.15	-0.05	-0.13	-0.13
employs	0.001	0.001	0.001	0.001	0.001	0.001
revenue	1.5e-7	1.4e-7	1.4e-7	1.5e-7	1.8e-7	1.9e-7
agein2008	0.027	0.068**	0.001	0.031	0.027	0.026
patnum		-0.00				
licenseout			0.52			
sellservice				0.18		-0.22
sellprod					-0.19	-0.43*
N	943	535	531	765	749	650
log likelihood	-1030	-555	-567	-846	-820	-712

TABLE A2: MODEL 1—AVERAGE MARGINAL EFFECTS OF FACTORS FOR IMPORTANCE OF TRADE SECRECY
(of each independent variable, holding others constant at their means)

	1	2	3	4	5	6
patents	0.062***	0.068***	0.083***	0.067***	0.061***	0.063***
firstmover	0.065***	0.075***	0.068***	0.066***	0.064***	0.064***
reverseeng	0.039***	0.040***	0.028***	0.035***	0.045***	0.042***
strategy-prod	0.018	0.0031	0.0061	0.021	0.014	0.017
trademarks	0.0069	0.023	0.0039	0.0055	0.0023	0.000022
comple-mentassets	0.022***	0.026**	0.034***	0.021**	0.024**	0.026***
copyright	0.0067	0.020	0.0040	0.0046	0.0079	0.0084
strategy-design	0.0069	0.0037	0.019**	0.0084	0.016**	0.015*
strategy-process	0.026***	0.037***	0.041***	0.025**	0.034***	0.039***
shareeng	0.058***	0.12***	0.053*	0.058**	0.041	0.037
strategy-model	0.011	0.0094	0.017	0.0055	0.014	0.015
employs	0.000091	0.00011	0.000094	0.000085	0.00011	0.00011
revenue	1.6e-8	1.6e-8	1.6e-8	1.6e-8	2.0e-8	2.2e-8
agein2008	0.0030	0.0077**	0.00014	0.0036	0.0030	0.0029
patnum		7.3e-6				
licenseout			0.059			
sellservice				0.021		0.025
sellprod					0.022	0.049*

TABLE A3: MODEL 2—FACTORS FOR IMPORTANCE OF TRADE SECRECY CONTROLLING FOR INDUSTRY

	1	2	3	4	5	6
patents	0.44***	0.52***	0.59***	0.46***	0.44***	0.47***
firstmover	0.59***	0.66***	0.62***	0.58***	0.57***	0.56***
reverseeng	0.36***	0.35***	0.27***	0.31***	0.41***	0.36***
strategy-prod	0.16	0.04	-0.07	0.19*	0.12	0.14
trademarks	0.08	0.21	0.06	0.07	0.04	0.02
comple-mentassets	0.20***	0.24**	0.30***	0.19**	0.22***	0.23***
copyright	0.11	-0.15	0.09	0.09	0.12	0.10
strategy-design	0.06	0.024	0.19**	0.06	0.14*	0.12
strategy-process	0.23***	0.32***	0.36***	0.21**	0.30***	0.33***
shareeng	0.52**	1.03***	0.44	0.50**	0.37	0.31
strategy-model	-0.069	-0.068	-0.11	-0.019	-0.094	-0.11
employs	0.001	0.001	0.001	0.001	0.001	0.001
revenue	1.5e-7	9.2e-8	9.6e-8	1.4e-7	1.8e-7	1.9e-7
agein2008	0.028	0.070**	0.001	0.032	0.028	0.025
Patnum		-0.0002				
licenseout			0.45			
sellservice				0.29		-0.13
sellprod					-0.21	-0.39
biotech	0.26	-0.0077	0.44	0.20	0.27	0.19
meddevice	-0.093	-0.16	-0.23	-0.036	-0.028	-0.16
software	-0.46**	-0.34	-0.49	-0.51**	-0.38	-0.35
ithardware	-0.029	-0.24	-0.064	-0.0085	0.071	0.083
N	943	535	531	765	749	650
log likelihood	-1024	-554	-562	-840	-816	-709

TABLE A4: MODEL 2—AVERAGE MARGINAL EFFECTS CONTROLLING FOR INDUSTRY

	1	2	3	4	5	6
patents	0.049***	0.059***	0.066***	0.054***	0.049***	0.054***
firstmover	0.065***	0.076***	0.069***	0.067***	0.064***	0.065***
reverseeng	0.040***	0.040***	0.030***	0.036***	0.045***	0.042***
strategy-prod	0.018	0.0048	0.0084	0.022*	0.013	0.016
trademarks	0.0094	0.024	0.0070	0.0082	0.0040	0.0019
complem-entassets	0.023***	0.027**	0.034***	0.021**	0.024***	0.026***
copyright	0.012	0.017	0.0095	0.0099	0.013	0.012
strategy-design	0.0062	0.0028	0.021**	0.0069	0.015*	0.014
strategy-process	0.026***	0.036***	0.040***	0.024**	0.034***	0.038***
shareeng	0.058**	0.12***	0.050	0.058**	0.041	0.035
strategy-model	0.0076	0.0078	0.013	0.0022	0.011	0.012
employs	0.000078	0.00011	0.00011	0.000068	0.00012	0.00010
revenue	1.6e-8	1.1e-8	1.1e-8	1.6e-8	2.0e-8	2.2e-8
agein2008	0.0031	0.0080**	0.00014	0.0037	0.0031	0.0028
patnum		0.00002				
licenseout			0.051			
sellservice				0.033		0.015
sellprod					0.023	0.045
biotech	0.027	0.0009	0.046	0.023	0.029	0.021
meddevice	0.010	0.018	0.026	0.004	0.003	0.019
software	0.050**	0.039	0.054	0.058**	0.043	0.040
ithardware	0.0032	0.027	0.0072	0.0010	0.0078	0.0094

TABLE A5: MODEL 3—FACTORS FOR IMPORTANCE OF TRADE SECRECY CONTROLLING FOR FUNDER TYPE

	1	2	3	4	5	6
patents	0.59***	0.62***	0.76***	0.61***	0.57***	0.58***
firstmover	0.59***	0.67***	0.61***	0.58***	0.58***	0.57***
reverseeng	0.35***	0.35***	0.24***	0.31***	0.40***	0.36***
strategyprod	0.20*	0.04	-0.036	0.20*	0.15	0.17
trademarks	0.05	0.19	0.038	0.04	0.0077	-0.005
complementassets	0.21***	0.24**	0.30***	0.19**	0.22***	0.24***
copyright	0.051	-0.18	0.03	0.032	0.066	0.071
strategy-design	0.057	0.014	0.16**	0.071	0.14**	0.12*
strategy-process	0.22***	0.32***	0.36***	0.21**	0.29***	0.33***
shareeng	0.54***	1.04***	0.51*	0.53**	0.37	0.34
strategy-model	-0.094	-0.072	-0.15	-0.048	-0.12	-0.13
employs	0.001*	0.001	0.001	0.001	0.001	0.001
revenue	1.6e-7	2.3e-7	2.1e-7	2.0e-7	1.8e-7	2.5e-7
agein2008	0.026	0.065**	0.001	0.032	0.026	0.026
Patnum		0.00036				
licenseout			0.51			
sellservice				0.18		-0.25
sellprod					-0.20	-0.46*
Ibankfunded	-0.13	-0.17	-0.04	-0.25	-0.04	-0.18
cbankfunded	0.21	0.17	0.11	0.17	0.12	0.075
friendsfunded	-0.024	0.040	0.14	0.064	0.054	0.16
angelfunded	-0.079	-0.104	-0.23	-0.18	-0.046	-0.22
vcfunded	-0.15	-0.33*	-0.062	-0.058	-0.16	-0.076
N	943	535	531	765	749	650
log likelihood	-1028	-552	-566	-844	-819	-710

TABLE A6: MODEL 3—AVERAGE MARGINAL EFFECTS BY FUNDER TYPE

	1	2	3	4	5	6
ibankfunded	0.015	0.019	0.0047	0.030	0.0047	0.021
cbankfunded	0.023	0.020	0.013	0.020	0.013	0.0085
friendsfunded	0.0027	0.0046	0.016	0.0073	0.0061	0.0019
angelfunded	0.0088	0.012	0.026	0.021	0.0052	0.026
vcfunded	0.017	0.038*	0.0070	0.0067	0.018	0.0087

TABLE A7: FACTORS FOR IMPORTANCE OF PATENTING

	1	2	3	4	5	6
secrecy	0.77***	0.62***	0.93***	0.74***	0.73***	0.69***
firstmover	0.29***	0.12	0.34***	0.28***	0.32***	0.27***
reverseeng	0.16**	-0.10	0.26***	0.21***	0.22***	0.25***
strategyprod	0.77***	0.73***	0.87***	0.47***	0.74***	0.49***
trademarks	0.39***	0.63***	0.37***	0.41***	0.46***	0.45***
complem-entassets	-0.13*	-0.33***	-0.16	-0.07	-0.20**	-0.13
copyright	-0.15	0.03	-0.17	-0.09	-0.13	-0.08
strategy-design	0.032	-0.078	-0.026	-0.010	0.003	0.008
strategy-process	-0.13*	-0.019	-0.27**	0.13	-0.23**	0.017
shareeng	0.43**	0.45	0.82***	0.63***	0.26	0.59**
strategy-model	-0.06	-0.05	0.05	-0.05	-0.04	-0.01
employs	0.00	-0.00	0.00	0.00	0.00	0.00
revenue	-1.5e-7	-12e-7***	-1.3e-7	-0.5e-7	-1.6e-7	-1.8e-7
agein2008	-0.031*	-0.11***	-0.026	-0.038*	-0.025	-0.017
patnum		0.45***				
licenseout			0.067			
sellservice				-1.66***		-2.40***
sellprod					-0.07	-1.36***
N	943	535	531	765	749	650
log likelihood	-1070	-470	-567	-840	-860	-699

TABLE A8: AVERAGE MARGINAL EFFECTS OF FACTORS FOR IMPORTANCE OF PATENTING

	1	2	3	4	5	6
secrecy	0.094***	0.066***	0.11***	0.092***	0.091***	0.086***
firstmover	0.035***	0.012	0.042***	0.034***	0.040***	0.033***
reverseeng	0.019**	0.010	0.032***	0.026***	0.028***	0.031***
strategyprod	0.095***	0.078***	0.106***	0.058***	0.091***	0.060***
trademarks	0.047***	0.067***	0.045***	0.052***	0.057***	0.056***
complementassets	0.016*	0.035***	0.019	0.009	0.025**	0.016
copyright	0.018	0.0037	0.021	0.011	0.016	0.0094
strategy-design	0.0039	0.0084	0.0032	0.0012	0.0004	0.0010
strategy-process	0.016*	0.0020	0.033**	0.016	0.028**	0.0021
shareeng	0.052**	0.048	0.101***	0.079***	0.033	0.073**
strategy-model	0.0068	0.0049	0.0057	0.0069	0.0045	0.0013
employs	9.7e-6	0.000042	8.9e-6	0.000020	0.000013	0.000029
revenue	1.8e-8	1.3e-7***	1.6e-8	6.7e-9	2.0e-8	2.3e-8
agein2008	0.0039*	0.012***	0.0031	0.0047*	0.0031	0.0022
patnum		0.0048***				
licenseout			0.0082			
sellservice				0.21***		0.30***
sellprod					0.0089	0.17***