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Do Patents Facilitate Financing in the Software Industry?

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This Article is the first part of a wide study of the role of intellectual property in the software industry. Unlike previous papers that focus primarily on software patents—which generally are held by firms that are not software firms—this Article provides a thorough and contextually grounded description of the role that patents play in the software industry itself.

The bulk of the Article considers the pros and cons of patents in the software industry. The Article starts by emphasizing the difficulties that prerevenue startups face in obtaining any value from patents. Litigation to enforce patents is impractical for those firms. Efforts to

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obtain patents divert the firm's focus from the central task of designing and deploying a product, and the benefits of excluding competitors are limited for firms that cannot themselves exploit the relevant technology. Once the firm is larger, a number of potential benefits appear. First, despite concerns that patents are not effective to appropriate profits from innovation in the software industry, a substantial number of software startups do have patents of sufficient strength to exclude competitors. That important finding, taken with the fact that the principal targets of those patents are much larger firms, suggests patents are more beneficial to small firms than to large firms. The Article then considers indirect effects related to the use of patents in cross-licensing transactions and in providing information about the firm. The first benefit may be substantial to firms that obtain patents, but the Article rejects patent use in cross-licensing as a net benefit to the industry: absent some other benefit, all firms would be better off saving the costs of obtaining patents. The information benefits, in contrast, seem to be net improvements to the innovation system. The central question, which I do not attempt to answer here, is whether those benefits are sufficiently substantial to justify the costs of obtaining the patents.

The Article then turns to the prominent claims that the enforcement of software patents has hindered innovation in the software industry through creation of a patent "thicket." The Article rejects those claims for two broad reasons. First, notwithstanding the empirical analysis of R&D spending in papers by Bessen, Maskin, and Hunt, direct evidence of high R&D spending in the software industry undermines claims that software patents cause firms to reduce R&D spending. Second, the actual structure and practices of the industry belie any claim of a patent thicket. Relying on interviews that I conducted and publicly available information, I show that the development of young firms in the software industry is not significantly constrained by large patent portfolios in the hands of incumbent firms.

The Article also contextualizes the role of patents by examining the relatively weak protections that copyright and trade secret afford. At bottom, neither of those systems can provide a useful mechanism that allows small firms to appropriate the values of their inventions. If such protection is a significant positive benefit of the patent system, it is equally true that neither copyrights nor trade secrets contribute (or can contribute) significantly in that respect, however useful they might be in other roles (such as preventing piracy).

The Article closes by considering critically the possibility of middle ground responses that would limit patent rights in the industry but not abolish them entirely. First, I criticize a possible registration system that might provide information benefits without the costs of excluding competitors. I argue that such an approach is impractical both because it would be difficult to disentangle the information benefits from the right to control technology and because of my sense that software firms would have an inadequate incentive to participate in such a system. Second, I consider the possibility of special limits on the rights of "trolls," small nonoperating firms formed solely to litigate patents. Trolls serve a useful function as specialized intermediaries and thus in fact may have a positive role in promoting innovation in the industry. Third, I consider the possibility that slight alterations in the patent rules for enablement and disclosure might mitigate the risks trolls pose to the licensing equilibrium that currently minimizes the costs of patenting in the software industry.

I. Introduction

The U.S. software industry is characterized by astonishing levels of growth, innovative activity, and competition.[1] Some argue that innovation in software and related industries has driven much of the innovation in other industries in recent decades.[2] Federal government statistics suggest that it is one of the few information technology sectors that consistently shows a large trade surplus,[3] and as the pressures of globalization dilute the comparative advantage of American employees in many sectors, it is worth noting the remarkable level of employment growth in the software industry over the last decade, from 854,000 jobs in 1992 to more than 2.1 million jobs in 2000 (a 12% annual growth rate).[4]

Academics, however, generally see a different picture. They see an industry burdened by an intellectual property (IP) system which grants so

1. David C. Mowery, *The Computer Software Industry*, *in* SOURCES OF INDUSTRIAL LEADERSHIP: STUDIES OF SEVEN INDUSTRIES 133 (David C. Mowery & Richard R. Nelson eds., 1999).

2. *See id.* at 164 (arguing that computer software's "influence within the innovation processes of other capital-goods and consumer durable industries appears to be growing steadily").

3. *See* U.S. DEP'T OF COMMERCE, ECON. AND STATISTICS ADMIN., DIGITAL ECONOMY 2002, at 53, *at* https://www.esa.doc.gov/reports/DE2002r1.pdf (Feb. 2002) (noting trade surpluses in the software industry of more than $2.5 billion a year during the late 1990s).

4. *Id.* at 43. During that period, employee wages grew at an average annual rate of 7.8%, for an average wage in 2000 of $80,900, the highest in any of the information-technology-producing industries. *Id.*

many software patents[5] that small companies cannot effectively innovate.[6] That perspective interests me for several reasons. First, unless it is merely a broader attack on the entire IP system,[7] it assumes that innovation in software is so different from innovation in other areas that traditional IP protections are inappropriate. It also is at odds with my general skepticism about the deterministic effect of legal institutions. My intuition is to doubt that legal rules granting patent protection have a sufficiently substantial effect to alter the course of innovation in *either* direction.

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5. As I explain below, it is difficult to get precise numbers. *See infra* text accompanying note 9. It is clear, however, that the Patent and Trademark Office (PTO) is granting far more than 10,000 software patents each year. Allison and Lemley document 18,000 software patents during a two-year period from 1996 to 1998. John R. Allison & Mark A. Lemley, *Who's Patenting What? An Empirical Exploration of Patent Prosecution*, 53 VAND. L. REV. 2099, 2115 (2000). Their number is extrapolated from a sample of all patents issued during that period, using a methodology that treats a patent as a software patent only if it is "completely embodied" in software. *Id.* at 2110, 2115. Greg Aharonian's somewhat broader measure (which appears to encompass any patent that includes an element of software) estimates 13,000, 17,500, and 21,000 in 1997, 1998, and 1999, respectively. *See* Posting of Greg Aharonian to patents@aful.org, *at* http://www.aful.org/wws/arc/patents/2000-02/msg00014.html (Feb. 15, 2000).

6. *See* FED. TRADE COMM'N, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY 52–53 (2003) [hereinafter FTC REPORT] (reporting testimony at FTC hearings on the role of patents in the software industry); LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD 205–15 (2001) (criticizing the patent system in light of recent developments that have greatly expanded patent law doctrine); Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting*, *in* INNOVATION POLICY AND THE ECONOMY 119, 121 (Adam B. Jaffe et al. eds., 2001) (stating that the U.S. patent system "is in danger of imposing an unnecessary drag on innovation by enabling multiple rights owners to 'tax' new products, processes, and even business methods"); James Bessen & Eric Maskin, Sequential Innovation, Patents, and Imitation 2 (Jan. 2000) (unpublished manuscript, on file with the Texas Law Review) [hereinafter Bessen & Maskin, Sequential Innovation] (proposing that strong intellectual property protection in the software and computer industries actually inhibits innovation); James Bessen, *Patent Thickets: Strategic Patenting of Complex Technologies*, *at* http://www.researchoninnovation.org/thicket.pdf (Mar. 2003) [hereinafter Bessen, *Patent Thickets*] (arguing that patent thickets reduce research and development incentives generally, while aggressive cross-licensing allows incumbent firms to "obtain a greater share of profits").

7. Adam Jaffe and Josh Lerner emphatically present a broader criticism in their recent book, ADAM B. JAFFE & JOSH LERNER, INNOVATION AND ITS DISCONTENTS (2004). Generally, they argue that the creation of the Federal Circuit has tilted the scales so far in favor of easier patentability as to create a cloud of uncertainty that stifles innovation generally. John Barton similarly argues that the growth of IP lawyers at a faster pace than R&D spending indicates a serious problem in the design of our patent system. John H. Barton, *Reforming the Patent System*, 287 SCI. 1933, 1933 (2000); *see also* Don E. Kash & William Kingston, *Patents in a World of Complex Technologies*, 28 SCI. & PUB. POL'Y 11, 11 (2001) (arguing that patents do not work in complex industries because they are used as bargaining chips). Doubts about whether the patent system as a whole causes an increase in innovation are not new. *See* Arnold Plant, *The Economic Theory Concerning Patents for Inventions*, 1 ECONOMICA 30, 33–37 (1934) (addressing the impact of the patent system on invention by first examining the array of additional factors that may influence the amount of invention that takes place); *see also* Edwin Mansfield, *Patents and Innovation: An Empirical Study*, 32 MGMT. SCI. 173, 173–75 (1986) (presenting data on inventions that would have been made without patent protection).

The existing literature on the subject[8] focuses on the nature and effects of software patents. Most writers proceed by identifying patents that fall within the PTO or IPC classes that correspond most closely to software innovation; they then examine data about the performance and behavior of the firms that hold those patents. That approach—although useful in examining the nature of software patents and the work of the PTO—has two major disadvantages for the broader agenda of evaluating the effects of software patents. First, the quality of the research depends entirely on the propriety of the definition of a "software" patent. Because software is a recently devised technology, it does not fall naturally within any particular class or classes. Thus, any definition that relies on patent classes is to some degree arbitrary.[9] Moreover, large manufacturing firms (Ford, GM, and the like) outside the software industry hold the overwhelming majority of the patents that such papers analyze.[10] Thus, it is unclear whether the empirical results reflect the effects of the software patents or whether similar results would be obtained for firms that receive substantial revenues from the sale of software products or services.

This Article rejects that approach, opting instead to analyze innovation in the software industry itself.[11] My approach identifies firms that develop software and then studies the effects of IP on the behavior of those firms. Thus, I focus on firms like IBM, Microsoft, and their smaller competitors that often are ignored in the existing research. My project also examines the smaller firms in the industry, rather than looking exclusively at large, publicly traded companies.[12] Given the importance of small companies to

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8. Although Lessig publicizes the issue, he does not present any new data. His contribution is to provide a perspective on the implications of the existing literature. LESSIG, *supra* note 6, at 211–15. The most important empirical contributions to the debate are Stewart J. H. Graham & David C. Mowery, *Intellectual Property Protection in the U.S. Software Industry*, *in* PATENTS IN THE KNOWLEDGE-BASED ECONOMY 219 (Wesley M. Cohen & Stephen A. Merrill eds., 2003), and a series of unpublished papers by James Bessen and his co-authors: Bessen & Maskin, Sequential Innovation, *supra* note 6; James Bessen & Robert Hunt, An Empirical Look at Software Patents (Mar. 2004) (unpublished manuscript, on file with the Texas Law Review) [hereinafter Bessen & Hunt, An Empirical Look]. The description in the text refers to those papers collectively.

9. *See* Allison & Lemley, *supra* note 5, at 2115 & n.51; Bessen & Hunt, An Empirical Look, *supra* note 8, at 8–9.

10. *See, e.g.*, Bessen & Hunt, An Empirical Look, *supra* note 8, at 16 (noting that "[t]he manufacturing sector acquires 75 percent of software patents").

11. In this respect, my work is parallel to the work of Hall and Ziedonis on the semiconductor industry. Bronwyn H. Hall & Rosemarie Ham Ziedonis, *The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979–1995*, 32 RAND J. ECON. 101 (2001).

12. Graham and Mowery also analyze patents in the software industry. Graham & Mowery, *supra* note 8. That paper makes many contributions, but it necessarily focuses on publicly traded firms for which quantitative data is readily available. Another useful analysis of the role of innovation in the industry is Robert P. Merges, *A Comparative Look at Intellectual Property Rights and the Software Industry*, *in* THE INTERNATIONAL COMPUTER SOFTWARE INDUSTRY 272 (David C. Mowery ed., 1996), which compares innovation in the United States and Japan. Because that

software innovation—a major theme of this Article—that extension is a substantial analytical advance.

My methodology is empirical and analytical. I rely on a set of about 60 interviews[13] with a variety of professionals[14] knowledgeable about the software industry: software developers, venture capitalists, angel investors, banks that lend to software startups, large software and hardware firms, and knowledgeable attorneys. Those interviews are designed to provide qualitative information about the motivations and practices that form the institutional environment within which software firms operate.

Analytically, I connect the interviews to well-developed literature relevant to questions the project raises. Initially, I account for a substantial body of doctrinal scholarship examining the question of how to accommodate existing IP law to the nature of innovation in the software industry.[15] Because my goal is to understand the relation between IP and innovation, I also engage the rich and varied economic analysis of innovation. That literature includes formal and informal analyses of how best to allocate the profits from ideas among the various actors in a sequential scheme of innovation,[16] historical analyses about the effects patents have had over time,[17] and empirical analyses (relying primarily on questionnaires)

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paper was written before the rise in patenting that has sparked the present debate, it necessarily does not address the industry as it has developed during recent years.

13. A methodological appendix summarizes the protocols that governed the interviews.

14. I spoke to twenty executives at startup firms, thirteen investors, thirteen executives at large firms, six executives at banks, and six lawyers.

15. Mark Lemley has argued that several characteristics of the industry justify giving software patents a narrow scope. Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1582–90 (2003); Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CAL. L. REV. 1 (2001). More broadly, the early work of Samuelson, Davis, Kapor, and Reichman advocates a *sui generis* scheme designed specifically for the industry. *E.g.*, Pamela Samuelson et al., *A Manifesto Concerning the Legal Protection of Computer Programs*, 94 COLUM. L. REV. 2308 (1994); Pamela Samuelson, Benson *Revisited: The Case Against Patent Protection for Algorithms and Other Computer Program-Related Inventions*, 39 EMORY L.J. 1025 (1990). At this time, such a scheme probably would conflict with our obligations under TRIPS, the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights. *See* Burk & Lemley, *supra*, at 1634–35.

16. The work of Suzanne Scotchmer is impressive. *See* Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and the Patent Law*, 5 J. ECON. PERSP. 29 (1991); Jerry R. Green & Suzanne Scotchmer, *On the Division of Profit in Sequential Innovation*, 26 RAND J. ECON. 20 (1995); Pamela Samuelson & Suzanne Scotchmer, *The Law and Economics of Reverse Engineering*, 111 YALE L.J. 1575 (2002). For a useful survey of the literature, see Roberto Mazzoleni & Richard R. Nelson, *Economic Theories About the Benefits and Costs of Patents*, 32 J. ECON. ISSUES 1031 (1998).

17. *See, e.g.*, Robert P. Merges & Richard R. Nelson, *On Limiting or Encouraging Rivalry in Technical Progress: The Effect of Patent Scope Decisions*, 25 J. ECON. BEHAV. & ORG. 1 (1994) [hereinafter Merges & Nelson, *Encouraging Rivalry*]; Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839 (1990) [hereinafter Merges & Nelson, *Patent Scope*]; PETRA MOSER, HOW DO PATENT LAWS INFLUENCE INNOVATION? EVIDENCE FROM NINETEENTH-CENTURY WORLD FAIRS (Nat'l Bureau of Econ. Research, Working Paper No. w9909, 2003), *available at* http://www.nber.org/papers/w9909. Merges has also written

regarding the value of patents in reaping the profits of innovation in various industries.[18] Finally, because I am interested in the ability of patents to facilitate financing of software firms, I examine empirical studies of entrepreneurial innovation, which consider the nature and effects of venture capital investing.[19]

Any effort to examine the relation between patents and innovation must proceed with modest goals. It is not plausible to think that researchers can obtain the evidence necessary to determine whether patents cause innovation in an industry to proceed at an optimal rate in optimal directions.[20] Thus, my work here is consciously imprecise. My goal is to provide a richer understanding of the possible effects that patents have in the software industry. Using this methodology, I can only exclude explanations that are inconsistent with events "on the ground." I cannot hope to provide a comprehensive or definitive account of the effects of patents on innovation.

With that in mind, I set the stage in Part II with an overview of the software industry's structure and the debate about patenting in that industry. I follow with three substantive Parts that discuss in turn the potential benefits of patents in the industry, the potential costs of patents in the industry, and the role of copyright, trade secret, and other alternative schemes that a firm might use to protect its software-related innovations. Although the analysis is often contextual, it does have an overriding theme: The effects of patents are much more likely to benefit small firms and contribute to industry fragmentation than to benefit large firms and contribute to industry

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about the likelihood that businesses will develop private institutions for disseminating technology. Robert P. Merges, *A New Dynamism in the Public Domain*, 183 U. CHI. L. REV. 183 (2004) [hereinafter Merges, *New Dynamism*]; Robert P. Merges, *Institutions for Intellectual Property Transactions: The Case of Patent Pools*, *in* EXPANDING BOUNDARIES OF INTELLECTUAL PROPERTY: INNOVATION POLICY FOR THE KNOWLEDGE SOCIETY 123 (Rochelle Cooper Dreyfus et al. eds., 2001) [hereinafter Merges, *Institutions*]; Robert P. Merges, *Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations*, 84 CAL. L. REV. 1293 (1996) [hereinafter Merges, *Contracting into Liability Rules*].

18. Richard C. Levin et al., *Appropriating the Returns from Industrial Research and Development*, 1987 BROOKINGS PAPERS ON ECON. ACTIVITY 783; WESLEY M. COHEN ET AL., PROTECTING THEIR INTELLECTUAL ASSETS: APPROPRIABILITY CONDITIONS AND WHY U.S. MANUFACTURING FIRMS PATENT (OR NOT) (NBER Working Paper Series, Working Paper 7552, 2000), *available at* http://papers.nber.org/papers/w7552; *see also* Mansfield, *supra* note 7, at 176–79.

19. *See, e.g.*, PAUL A. GOMPERS & JOSH LERNER, THE MONEY OF INVENTION: HOW VENTURE CAPITAL CREATES NEW WEALTH (2001) [hereinafter GOMPERS & LERNER, THE MONEY OF INVENTION]; PAUL A. GOMPERS & JOSH LERNER, THE VENTURE CAPITAL CYCLE (2000) [hereinafter GOMPERS & LERNER, THE VENTURE CAPITAL CYCLE].

20. Most modern studies assume that increases in innovation are uniformly good and thus do not consider the possibility that the patent system might cause excessive innovation. *E.g.*, Merges & Nelson, *Patent Scope*, *supra* note 17, at 878 (recognizing the problem, but explicitly assuming that more innovation is better). The classic counterexample is Yoram Barzel, *Optimal Timing of Innovations*, 50 REV. ECON. & STAT. 348 (1968) (offering a formal analysis of the possibility that patents will cause innovation that is greater or earlier than optimal).

concentration.[21] Among other things, I find the common thesis that large firms use a patent "thicket" to fence out potential competitors most implausible. I close with a brief and skeptical discussion of several possible responses to the imperfections of the existing system.

II. The Software Industry

It is important to begin with an understanding of the industry's structure. The industry is young. It generally is regarded as originating in the mid-1960s.[22] The concept of the software product—a product designed by firm *A* and sold to firm *B* for use on firm *B*'s computer—first originated because of the increasing complexity of software[23] and a shortage of the labor needed for each hardware firm to make its own software.[24] The most crucial event was IBM's decision in late 1968 to "unbundle" its software from its hardware.[25] Sales of software products grew rapidly throughout the 1970s. By the 1980s, the United States had a large and well-developed corporate software products industry with more than 1,800 firms.[26]

The industry was not, however, fated to retain the unitary status it had when it first evolved out of the IBM-dominated days of the 1960s. On the contrary, the last quarter-century has seen a succession of events that have repeatedly broadened the industry's traditional focus on software for use by business enterprises. The number of developments makes any list of key events arbitrary, but for my purposes the first salient landmark in the fragmentation of the industry was the introduction of the personal computer in the mid-1970s. That development rapidly led to a largely separate set of companies producing software for personal computers.[27] The popularization of the graphical user interface in the early 1990s brought with it an increasingly large role for Microsoft, but to this day dozens of competitors

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21. This analysis contradicts the increasingly widely accepted notion that patents systematically favor incumbent firms over entrants. *E.g.*, GIDEON PARCHOMOVSKY & R. POLK WAGNER, PATENT PORTFOLIOS 64–65 (Univ. of Pa. Law Sch. Pub. Law & Legal Theory Research Paper Series, No. 56, 2004) (arguing that "the size-effects of [a significant patent] portfolio . . . offer a powerful leveraging tool" that can enhance the holder's bargaining position vis-à-vis competitors, suppliers, and distributors), *available at* http://papers.ssrn.com/abstract=582201.

22. *See* MARTIN CAMPBELL-KELLY, FROM AIRLINE RESERVATIONS TO SONIC THE HEDGEHOG: A HISTORY OF THE SOFTWARE INDUSTRY 89–119 (2003).

23. Observers at the time—including IBM management—were profoundly shocked when it took 5,000 man-years for IBM to develop its OS/360 program. *Id.* at 95.

24. The shortage was driven in part by the rapid deployment of general purpose computers: the number in the U.S. grew from 4,400 in 1960 to 48,500 in 1970. CAMPBELL-KELLY, *supra* note 22, at 90; VERNON W. RUTTAN, TECHNOLOGY, GROWTH AND DEVELOPMENT: AN INDUCED INNOVATION PERSPECTIVE 338 (2001).

25. *See* MICHAEL A. CUSUMANO, THE BUSINESS OF SOFTWARE 93–95 (2004). Although IBM has more complicated explanations for the decision to unbundle, external observers attribute the decision to pressures from antitrust litigation. *See* CAMPBELL-KELLY, *supra* note 22, at 109–10.

26. *See* CAMPBELL-KELLY, *supra* note 22, at 165–73.

27. *See id.* at 201–28; RUTTAN, *supra* note 24, at 338–39; Graham & Mowery, *supra* note 8, at 3–4.