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The Commercial Value of Software Patents in the High-Tech Industry

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EXECUTIVE SUMMARY

Patents play an important role in commercializing software innovation and supporting technology markets. Understanding this commercial role requires a broader view of patents in software innovation than the all-too-common focus on a small handful of litigated patents and legal questions of patentability and patent quality. To understand the commercial value of patents in software innovation, it is helpful to consider two features of the patent system that favor flexibility over rigidity.

First, patents provide an essential economic opportunity not only to trade rights in innovative technology, but also to develop the underlying technology further. This kind of flexibility enables businesses that manufacture products to do so directly and recoup their investments. It also enables innovators whose talent is developing technology (but not producing it) to license to others through tailored agreements to bring products to market. And it enables startup companies to attract capital and compete effectively with powerful market incumbents.

Second, the patent system operates largely through default rules that are optional in the sense that people and firms can transact around them. This kind of flexibility offers important gap-fillers where parties leave the terms of an agreement unstated, and it also allows companies to create economic relationships and ventures in line with their own specific circumstances. This is especially important in the high-tech industry, where companies constantly make difficult tradeoffs and justifying risky investments requires as much economic flexibility as possible.

Where these two features interact effectively, the result has been the emergence of new markets for the exchange of technology and knowledge, particularly in the case of software. Software is economically portable among technological and commercial sectors, and it is pervasive and widely adopted across the economy. In fact, the more general a software technology is and the further downstream a particular product market is, the more likely it is that patent owners and manufacturers will make license agreements around the software. What allows these agreements to succeed is a stable system of underlying patent property rights.

Without the efficiencies of the patent system, innovators would be ill-equipped to account for their particular economic needs when grappling with risky investments. Understanding the commercial value of patents in software innovation offers a way to move beyond well-worn legal arguments and focus instead on the important practical questions that patent policy must answer.

The Commercial Value of Software Patents in the High-Tech Industry

SAURABH VISHNUBHAKAT

Computer software has sparked a highly contested debate about whether the patent system should protect it. The debate has focused mostly on legal issues, such as whether software is patentable at all or whether software patents are of appropriate legal quality or not.[1] To that important policy debate, this essay contributes a point that has been underappreciated so far: software patents play an important role in commercializing innovation and creating markets for technology and knowledge.

Why We Hear So Little About the Commercial Role of Patents

One reason for the legal focus of the current patent policy debate is that it has been limited to questions that arise from patent litigation.[2] There is no comparable focus on what happens in the important middle ground between when a patent is issued and when (if ever) it is litigated. The reason for the focus on litigation is simply that this is where the data has been available.[3] Patent examination is an arcane process, and systematic data about it used to be hard to obtain.

Similarly, licenses and other manufacturing details are valuable information that companies in the innovation industries have always kept secret. Lawsuits, however, are public documents and available for data mining by legal and economic scholars.

The situation began to change in 2010, when comprehensive data started becoming available about the patent examination process. Since then, the United States Patent and Trademark Office (PTO) has increasingly published data about patent applications, patent grants, and the administrative processes that apply to patents after they are issued.[4] This data boom about patent applications is significant because litigation alone represents a very small and selective subset of patents that are not representative of the patent system as a whole. For the last two decades, the PTO has issued over 100,000 patents each year.[5] In the same time period, the PTO has received an average of twice as many new applications each year as it issued.[6] Meanwhile, only 1–2% of patents are ever litigated.[7] And as scholars have repeatedly observed, these patents are systematically different from the general population of patents.[8]

Still, the picture remains incomplete. No comparable data exists about what happens after the patent is issued but before it is litigated, if ever. And that middle ground is where the real business purposes of patents reside. Companies ranging from small startups to large corporations use patents for a variety of commercial purposes: for licensing to bring technologies to market, as collateral to secure debt and financing, and as market signals to attract investment, to name a few. The scope for these activities is obviously quite large: any of the 98–99% of patents that are never litigated could be used in these ways. Indeed, even patents that are eventually litigated are often vetted first in the marketplace, with litigation following when commercial bargaining breaks down. The tremendous gap in the data about these commercial activities explains why we hear relatively little about the commercial role of patents.

There is also good reason to think that this data gap is important—that the reasons why individuals and companies use patents as commercial assets are economically meaningful. For example, a detailed 2012 report prepared by the PTO and the Economics and Statistics Administration found that 75 industries out of 313 total rely strongly enough on intellectual property to be regarded as "IP-intensive industries."[9] Of these, 26 are patent-intensive industries, accounting for 3.9 million jobs and 5.3% of GDP, or about $763 billion of value added, in 2010.[10]

How to Understand the Commercial Role of Patents

Still, though there is less data than we ultimately will need for the full picture, lessons from increasingly sophisticated economic and business research can help clarify matters. It is well-documented that innovators rely on patents as innovation incentives to varying degrees across different technology sectors and industries.[11] So one particularly important question we should ask now is, once innovations have come into existence, how do patents encourage entrepreneurs to bring those innovations to consumers?

There are two useful and related ways to address that question. One is that patents directly create opportunities for productive commercial activity, opportunities that economic theory calls "options." The second is that patents support the creation of markets for technology and knowledge, and thus coordinate that productive commercial activity. These two approaches highlight the often overlooked role of patents in enabling new market transactions in software-related inventions.

Notably, these approaches also allow us to move beyond the well-worn semantic debates about the patentability of software, such as what counts as an unpatentable "abstract idea" or "law of nature."[12] These debates are important, but so is understanding the practical function of patented innovation in the high-tech industry—and this latter assessment is overdue.

Patent Rights as Options: Lessons from Economic Theory

As a property right, a patent provides its owner the ability to exclude others from economic activities centered on the patented invention: making, using, selling, offering to sell, and importing.[13] In other words, patents clear the field and leave the patent owner the choice of engaging in those activities for itself. This basic choice is an economic option, an opportunity to participate in some type of market transaction.

Many people are aware of options in the context of finance, such as the option to buy or sell a share of stock at a fixed price.[14] But the economic concept of an option is broader than just stock transactions, and it also applies to the commercial choices available to patent owners. In fact, patents provide an even more substantial prospect than stock options: they secure the freedom to engage in a wide variety of commercial activities to *develop and increase the value* of the underlying asset, not just to buy or sell it.[15] This understanding of patent rights as options is helpful because it highlights the commercial functions that patents serve, such as managing risk and building competitive advantage in the marketplace.[16]

Patent owners can exercise their options in a variety of ways. One way is to manufacture the patented technology, secure that others will not be able to copy it freely right away. This temporary protection from competition has two benefits. First, without rival companies immediately driving down the price, the patent owner will be able to recoup the investment that went into developing the technology in the first place—an incentive story that is familiar in patent policy.[17] Second, and equally as important, competitors also have the incentive and the means to develop and produce rival non-infringing products that enrich the market and provide consumers with even more choices. Because all patents must publicly disclose the invention,[18] competitors in the marketplace have access to the technological information necessary for creating rival products and services that achieve the results that consumers want, but without infringing the patent. This is not discussed much by non-patent specialists, but we are all aware of it given the incredible diversity of products and services in the high-tech economy, such as the many different types of laptops, smart phones, and tablets.

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Another way to exercise the patent option is to give permission to others to make, use or sell the invention. In patent parlance, one can either license (grant permission) to others to manufacture or assign (sell) the patent itself. The tradable nature of patents means that if one's particular skill is inventing but not manufacturing or retailing, then one can transfer a patent to those who do have these skills, and the technology can be more efficiently developed and sold in the market.[19]

The Business Value of Patent Options

For business managers who must make decisions under uncertainty about the future, such as whether a complex new product will be successful in the marketplace, options provide the necessary flexibility for making investments in creating future market value. This flexibility is important because without it, innovative companies face additional uncertainty about whether their investments will yield returns.[20] Without a way to manage this uncertainty through the patent option, business managers will avoid risky, long-term investments altogether, forgoing the technological breakthrough products and services that the patent system has made possible.

Software patents play an important role in commercializing innovation and creating markets for technology and knowledge.

The iPhone is an excellent case in point. The product itself was released in 2007. Yet Apple made the decision and began the necessary investments to create the iPhone more than seven years earlier. It registered the Internet domain name www.iphone.org in December, 1999.[21] It filed for trademarks in a number of countries, including Singapore, the United Kingdom, Australia, Canada, New Zealand, and the United States.[22] And it engaged in a robust marketing campaign beginning with its famous teaser advertisement in February, 2007, during the 79th Academy Awards—only three days after Apple had settled a dispute with Cisco over the U.S. trademark on the name iPhone.[23]

Turning the research and development of Apple's engineers into a commercial product also required extensive complementary innovation, such as the availability of Corning's high-strength sheet glass, marketed as Gorilla Glass. It required Apple to create and invest in supply and distribution chains. Apple's now-commonplace retail stores are an example of these investments. In retrospect, it is easy to think the iPhone was an inevitable success, but there were many prior failures in creating a smart phone by well-known companies like Motorola and Qualcomm. And Apple's business model for the iPhone, particularly its exclusive service arrangement with AT&T, had its detractors, including the famous IP and internet scholar Tim Wu.[24]

Still, Apple's investments in the iPhone were considerable and did not stop with its release. Even after 2007, the company increased its advertising budget by an average of 35% each year from $288 million in 2007 to over $2.3 billion in 2014.[25] The iPhone went on to account for about $30 billion of Apple's market value, and one-quarter of that $30 billion was generated by the market's reaction to the publication of Apple's patents.[26] The iPhone is a dramatic illustration in the high-tech industry of the lag between investments in innovation and production and the eventual creation of real-world market value. A patent is an option for a company like Apple to time its investments properly, and to do so throughout its production cycle and supply chain.

More generally, the iPhone is also a real-world example of how the economic theory of options applies to property rights in innovation. In studies of company performance in the innovation industries, scholars have shown that patenting tends to raise the *market value* of a patent-owning company relatively quickly—but that patenting also tends to raise the company's *overall productivity* more slowly. Although this may seem paradoxical at first, the lag makes sense by understanding patents as options. Market value can respond right away to a company's signals, including the very fact that the company owns patents at all.[27] But productivity gains may require further R&D in the invention itself, as well as further investment in related commercial activities, such as marketing.[28]

Understanding patents as options also provides insights into company decision-making in the innovation industries, including the high-tech sector. Companies must make investments and offer products and services in the market based not only on what their own circumstances suggest, but also on what their rivals are doing. Unexpected moves by a competitor, such as a new product announcement, can make a company immediately change its R&D plans and commercial activities and thus erode the flexible timing that the company would otherwise enjoy.[29]

To stay with the iPhone example, despite all the long-planned investment that had gone into the release, the announcement itself was a famously well-guarded secret.[30] It was also a major setback for one of Apple's chief competitors, Google, whose engineers had been working continuously for fifteen months on its first Android smart phone prototype to challenge Microsoft in the mobile phone market.[31] When Apple announced the iPhone, Google had to change its technology and business strategies in a matter of weeks and did not enter the market with its G1 Android smart phone until almost two years later in late 2008.[32]

Given these ever-present risks of competition and delay in the marketplace, companies make investment decisions based on carefully assessed tradeoffs between business models and legal protections available through different mechanisms, such as patents versus trade secrets.[33] These kinds of commercial choices are possible only because of the options that arise from property rights in innovation. Such choices are particularly important in the high-tech industry, which is uniquely characterized by an extremely fast pace in the development of new and competing

products and services. The economic theory of options helps us better recognize how the patent system effectively promotes and secures new innovation in this commercial context—by securing the investments and business decisions necessary for technological progress and thus facilitating the arrival of innovative technologies into the hands of consumers in the marketplace.

Optional Uses of Patents: Transacting Under Default Rules

Understanding patents as options offers additional insights into how technological innovation is created and brought to market in the high-tech industry. The commercial contracts and consumer sales of patented innovation operate primarily in a legal framework of what are called "default rules," which are legal rules that are optional in the sense that private parties can transact around them using contracts. As is well known among legal and economic scholars, default rules fill in the gaps when some important term of agreement in a contract is left unstated. So they are, strictly speaking, the default option when there is silence or disagreement between freely contracting parties.[34] Default rules allow for greater tailoring of agreements, transactions, and business models to individual economic circumstances.

Default rules differ from what are called "mandatory rules," which are absolute requirements or prohibitions as wide-ranging as speed limits, laws against murder, and food inspection rules by the U.S. Department of Agriculture. So even if two private parties wanted to, say, make a contract that the buyer would accept uninspected beef if the seller offered a discounted price, the agreement itself would be illegal. The USDA's mandatory rules regarding inspection put that issue off-limits to negotiation.

Although there are some mandatory rules in patent law, the majority of patent law comprises default rules. For example, courts have long held that employees have the right to patent their inventions as first inventors, but employees and their employers are free to transfer these rights by contract.[35] This is in contrast to patent systems such as Germany and Japan, which impose mandatory rules that all employees must receive patents on their own inventions.[36] Similarly, U.S. patent law provides that co-inventors receive joint ownership of patents by default.[37] Still, the statute leaves co-inventors free to enter into agreements that modify their respective rights to the patented invention.[38]

The patent system effectively promotes and secures new innovation by securing the investments and business decisions necessary for technological progress.

Even more important, default rules govern how patent owners can sell or otherwise convey their rights in the marketplace.[39] Generally, when a patent owner makes an unconditional sale of a patented item, that sale terminates the patent owner's rights over that item.[40] The purchaser may then freely resell it, rent it out, and so on. Yet patent owners have always been free to contract around this rule and impose express conditions on their sales of patented items. Because such sales are no longer unconditional, the general rule no longer applies. Thus, the ability of patent owners to control resale operates as a default rule.

This last example of resale as a default rule is particularly salient because it reveals that the flexibility of options is part of the structure of American patent law. Viewing patent transactions through the lens of default rules reveals that this form of optionality offers valuable flexibility in how the patent system both generates rights and allows them to be transacted in efficient and productive ways.[41] The interaction between default rules in the patent system and the flexibility of options in commerce is valuable because it supports the emergence of entire markets where technology and knowledge can be exchanged.

The Market Impact of Patent Options for New Technology, Particularly in Software

These two insights—patents represent options, and patents operate largely under default rules—help clarify why and how innovators use patents to secure their innovations, particularly in software. Patents support markets not only for producing new innovation, but also for distributing it to consumers the world over, as anyone reading this essay on a smart phone or tablet can attest.

In the world of tangible goods, markets provide familiar benefits. One benefit is economy of scale, where the cost of producing each unit drops as the overall scale of production expands. Another benefit is economy of

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learning, where unit cost drops over time as learning and know-how accumulate. And, of course, markets generally promote a more efficient division of labor. These market benefits are not limited just to tangible goods, however, but also extend to intangible goods such as technology and knowledge.[42] To understand the importance of patents as options in markets for technology, especially in the high-tech industry, it is important to ask why companies decide to license their technologies for others to use.

There are several possible reasons. One reason might be that a company lacks the ability to manufacture, as is often the case for individual inventors or undercapitalized startups. Another reason may be that a company wants to promote its invention as part of an industry-wide technical standard that is used in all devices or services, such as the WiFi wireless network standard that made possible the mobile revolution. Yet another reason may be that a company wants to offer its technology as an incentive to others so that they will adopt it as a platform and build on it, such as Microsoft's pioneering decision in the 1980s to license its Windows operating system to all computer manufacturers and software developers. Each of these reasons can lead to different business models and investment decisions in R&D as well as commerce. The flexibility of patents as options encourages the wide range of these choices in technological and commercial development.

And this kind of flexibility is not a luxury, particularly in the high-tech industry. Companies must constantly make difficult tradeoffs based on advances in technology, geographic constraints, the supply of highly trained workers, and the ever-changing preferences of consumers. To balance these and a great many other priorities, high-tech innovators and entrepreneurs need as much economic flexibility as they can get, or else their investments become that much more risky to justify. Mandatory rules, which have to be prepackaged as broad legal solutions, can almost never be tailored finely enough in advance to deal with the pace and complexity of market competition.

These insights into how patents function as options for the high-tech industry in general also illuminate the case of software in particular. Software is distinctly amenable to being traded in markets for technology, and this is no coincidence.

Software is a general-purpose technology, which means that it is pervasive and widely adopted in many different areas of the innovation economy and many different aspects of modern life.[43] It is, in a word, ubiquitous: software is not only in our laptops and phones but also in our cars, coffee machines, microwave ovens, refrigerators, and countless other consumer products. This reflects the fact that software as an economic good is generally portable among technological and commercial sectors.

As a result, software is a tradable asset that can be licensed or sold among companies at every point in the production or retail chain. In fact, economic research reveals that the more general a software technology is and the further downstream a particular product market is, the more likely it is that upstream owners of patented technology and downstream product manufacturers will make license agreements around the software technology.[44] This research also confirms the everyday experience that operating systems, software programs, apps, and other aspects of software in high-tech products and services are widely licensed, even by famously proprietary manufacturers like Apple.

Conclusion

Patents play an important and productive role in facilitating efficient transfers of technologies such as software, both because patents embody the knowledge itself that will be exchanged in the market and because patents offer the flexibilities of options and default rules. Without these valuable flexibilities of the patent system, innovators would be stymied in shaping transactions to their individual economic needs and would instead be left to bear increasingly unmanageable investment risks. Understanding the economic importance of patent options and the largely default-rule structure of the patent system helps to bring the focus where it really belongs in the patent policy debate: not on the vanishingly small subset of cases that are uncertain enough to fight about in court, but on the countless individual commercial activities that make up the modern innovation economy.

ENDNOTES

1 *See, e.g.,* Adam Mossoff, *A Brief History of Software Patents (And Why They're Valid),* CPIP Policy Brief (Sept. 2013), *available at* http://cpip.gmu.edu/wp-content/uploads/2013/08/A-Brief-History-of-Software-Patents-Adam-Mossoff1.pdf (arguing in favor of patent protections for software inventions); Pamela Samuelson, *Benson Revisited: The Case against Patent Protection for Algorithms and Other Computer Program-Related Inventions*, 39 Emory L.J. 1025, 1135–36 (1990) (arguing against patent protection for software inventions); Arti K. Rai, *Improving (Software) Patent Quality Through the Administrative Process*, 51 Hous. L. Rev. 503 (2013) (arguing for reforms to improve the quality of software patents) *and* Stuart J.H. Graham & Saurabh Vishnubhakat, *Of Smart Phone Wars and Software Patents*, 27 J. Econ. Persp. 67 (2013) (arguing that software-related patents are of comparable quality to patents in other fields by administrative examination metrics).

2 *See, e.g.,* Robert P. Merges, *As Many As Six Impossible Patents Before Breakfast: Property Rights for Business Concepts and Patent System Reform*, 14 Berkeley Tech. L.J. 577 (1999); David L. Schwartz & Jay P. Kesan, *Analyzing the Role of Non-Practicing Entities in the Patent System*, 99 Cornell L. Rev. 425 (2014); Saurabh Vishnubhakat, *What Patent Attorney Fee Awards Really Look Like*, 63 Duke L.J. Online 15 (2014).

3 Commercial databases such as Derwent, Lex Machina, and DocketNavigator have codified and disseminated information about patent litigation that was previously available only in unstructured form through the PACER service of the Administrative Office of the U.S. Courts. *See* Lex Machina, *available at* http://lexmachina.com/; DocketNavigator, *available at* http://docketnavigator.com/; Public Access To Court Electronic Records, *available at* http://www.pacer.gov/.

4 During 2010–2013, the USPTO made this information available through Google. *See* United States Patent and Trademark Office, *USPTO Teams with Google to Provide Bulk Patent and Trademark Data to the Public,* Press Release No. 10-22, *available at* http://www.uspto.gov/news/pr/2010/10_22.jsp. Since June 2013, the USPTO has partnered with Reed Technology and Information Services to continue providing this data. *See* RTIS, *Reed Technology Announces Launch of USPTO Public Data Dissemination Site, Expansion of Reed Tech Patent Advisor Service*, Wall St. J., June 20, 2013, *available at* http://online.wsj.com/article/PR-CO-20130620-908055.html.

5 Data on the last fifty years of U.S. patent applications and grants is available from the USPTO Patent Technology Monitoring Team. See USPTO PTMT, "U.S. Patent Statistics Chart Calendar Years 1963–2013," *available at* http://www.uspto.gov/web/offices/ac/ido/oeip/taf/us_stat.htm.

6 *Id.*

7 Adam B. Jaffe, *The U.S. Patent System in Transition: Policy Innovation and the Innovation Process,* 29 Res. Pol'y 531, 548 (2000).

8 *See generally* John R. Allison et al., *Valuable Patents*, 92 Geo. L.J. 435 (2004).

9 *See generally* ESA & USPTO, Intellectual Property and the U.S. Economy: Industries in Focus (2012), *available at* http://www.uspto.gov/news/publications/IP_Report_March_2012.pdf.

10 *Id.* at 40, 44–45.

11 The seminal empirical study of patents as one of several technology-specific incentives for innovation is Wesley M. Cohen et al., *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not),* Nat'l Bureau of Econ. Research Working Paper No. 7552 (2000). The more recent 2008 Berkeley Patent Survey further confirms that high technology startups in particular seek and own patents in ways and for reasons that are quite industry-specific. *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 (2009).

12 *See* Kristen Osenga, *Debugging Software's Schemas,* 82 Geo. Wash. L. Rev. (forthcoming); Christopher Holman, *The Critical Role of Patents in the Development, Commercialization, and Utilization of Innovative Genetic Diagnostic Tests*, CPIP Policy Brief (July 2014), *available at* http://cpip.gmu.edu/wp-content/uploads/2014/04/Holman-Critical-Role-of-Patents-in-Genetic-Diagnostic-Tests.pdf (discussing similar commercialization issues in genetic diagnostic testing and arguing that patents play a comparably important role in that setting).

13 35 U.S.C. § 154(a)(1).

14 Fischer Black & Myron Scholes, *The Pricing of Options and Corporate Liabilities,* 81 J. Pol. Econ. 637 (1973). Generally, the value of financial options are immune to the owner's actions. Because the buying or selling price of the financial option is fixed at the time of the option's creation, the value of the underlying asset (such as the stock) will change only according to market forces.

15 This ability to affect the value of the underlying asset is what distinguishes a "real option" from traditional financial options. See Marcus Schulmerich, Real Options Valuation 21–69 (2d ed., 2010) (introducing the theory and practice of real options). This technical distinction between real options and financial options is beyond the scope of this policy brief, and for ease of reference, I will describe patents simply as options.

16 *See, e.g.,* Stuart J.H. Graham & Ted M. Sichelman, *Patenting by Entrepreneurs: An Empirical Study,* 17 Mich. Telecom. & Tech. L. Rev. 111 (2010) (describing the strategic uses that entrepreneurs and start-up firms make of patents). *See also* Greg Dolin, *Resolving the Patent-Antitrust Paradox: Promoting Consumer Welfare Through Innovation*, CPIP Policy Brief (May 2013) (discussing how patents promote dynamic efficiency in the marketplace), *available at* http://cpip.gmu.edu/wp-content/uploads/2013/08/Dolin-Patent-Antitrust-Paradox.pdf.

17 *E.g.,* William M. Landes & Richard A. Posner, The Economic Structure of Intellectual Property Law 13, 294 (2003).

18 35 U.S.C. § 112(a) (requiring that the patent describe what the invention is, and how to make and use it, with enough clarity and completeness that someone with ordinary skill in that technology will understand).

19 Kenneth W. Dam, *The Economic Underpinnings of Patent Law,* 23 J. Legal Stud. 247, 256 (1994) (observing that, given the patent's exclusionary power, the patent owner and any potential infringer will normally have an incentive to enter a licensing agreement or even an outright sale of the patent if the infringer can put the patent to more efficient use).

20 Avinash K. Dixit & Robert S. Pindyck, Investment Under Uncertainty 135–36 (1994) (explaining that investing by net-present-value alone, rather than options analysis, improperly "ignores the opportunity cost of making a commitment now, and thereby giving up the option of waiting for new information").

21 Verio, *WHOIS Information for iphone.org*, available at http://whois.net/whois/iphone.org.

22 Timo Korkeamäki & Tuomas Takalo, *Valuation of Innovation: The Case of iPhone*, 10 Eur. Mgmt. Rev. 197, *12 (2013), *available at* https://sites.google.com/site/tuomastakalo/files/iPhone_EMR_Final.pdf.

23 Heather Won Tesoriero, *Apple & Cisco Hug It Out Over iPhone*, Wall St. J. Law Blog, Feb. 22, 2007, *available at* http://blogs.wsj.com/law/2007/02/22/apple-cisco-hug-it-out-over-iphone/.

24 Tim Wu, *iPhony*, Slate (June 29, 2007), *available at* http://www.slate.com/articles/technology/technology/2007/06/iphony.single.html.

25 Apple's annual accrued marketing expenditures are obtained from its 10-K reports to the Securities and Exchange Commission. *See* Apple Investor Relations, "SEC Filings," *available at* http://investor.apple.com/sec.cfm.

26 Korkeamäki & Takalo, *supra note* 22, at *23–24.

27 *See generally* Clarisa Long, *Patent Signals*, 69 U. Chi. L. Rev. 625, 664–65 (2002) (discussing the value of patents as market signals about a firm's attributes).

28 Nicholas Bloom & John Van Reenen, *Patents, Real Options and Firm Performance*, 112 Econ. J. C97 (2002).

29 *See* Lenos Trigeorgis, Real Options 273–304 (1996) (discussing the effect of competition on the option value of investment opportunities).

30 Peter H. Lewis, *How Apple Kept Its iPhone Secrets*, Fortune, Jan. 12, 2007, *available at* http://archive.fortune.com/2007/01/10/commentary/lewis_fortune_iphone.fortune/index.htm.

31 Fred Vogelstein, *The Day Google Had to 'Start Over' on Android*, The Atlantic, Dec. 18, 2013, available at http://www.theatlantic.com/technology/archive/2013/12/the-day-google-had-to-start-over-on-android/282479/.

32 *Id.*

33 *See* Ariane Reiss, *Investment in Innovations and Competition: An Option Pricing Approach*, 38 Q. Rev. Econ. & Fin. 635 (1998).

34 Ian Ayres & Robert Gertner, *Filling Gaps in Incomplete Contracts: An Economic Theory of Default Rules*, 99 Yale L.J. 87, 87, 91 (1989).

35 *See United States v. Dubilier Condenser Corp.*, 289 U.S. 178 (1933).

36 *See* Sonia Baldia, *The Transaction Cost Problem in International Intellectual Property Exchange and Innovation Markets,* 34 Nw. J. Int'l L. & Bus. 1, 41 n.169 (2013) (noting that Germany implements its employee inventorship rules through labor laws and that Japan does so by requiring compensation for employees who assign their patenting rights to employers).

37 35 U.S.C. § 262.

38 *Id.* (expressly limiting the joint ownership rule to "the absence of any agreement to the contrary").

39 *See* Adam Mossoff, *A Simple Conveyance Rule for Complex Innovation*, 44 Tulsa L. Rev. 707, 711–17 (2009) (explaining the patent exhaustion doctrine as a default rule).

40 *Jazz Photo Corp. v. ITC*, 264 F.3d 1094, 1102 (Fed. Cir. 2001).

41 F. Scott Kieff & Troy A. Paredes, *Engineering a Deal: Toward a Private Ordering Solution to the Anticommons Problem*, 48 B.C. L. Rev. 111 (2007).

42 *See* Ashish Arora & Alfonso Gambardella, *The Market for Technology*, in 1 Handbook of the Economics of Innovation (Bronwyn H. Hall & Nathan Rosenberg, eds.) (2010).

43 *See* Graham & Vishnubhakat, *supra note 1*, at 74 (2013); Timothy F. Bresnahan & Manuel Trajtenberg, *General Purpose Technologies: 'Engines of Growth'?*, 65 J. Econometrics 83 (1995).

44 *See, e.g.,* Stefano Brusoni, Andrea Prencipe & Keith Pavitt, *Knowledge Specialization, Organizational Coupling, and the Boundaries of the Firm: Why Do Firms Know More Than They Make?,* 46 Admin. Sci. Q. 597 (2001); Alfonso Gambardella & Salvatore Torrisi, *Does Technological Convergence Imply Convergence in Markets? Evidence from the Electronics Industry,* 27 Res. Pol'y 445 (1998).

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CENTER FOR THE PROTECTION OF INTELLECTUAL PROPERTY

The Center for the Protection of Intellectual Property (CPIP) at George Mason University School of Law is dedicated to the scholarly analysis of intellectual property rights and the technological, commercial, and creative innovation they facilitate. CPIP explores how strong property rights in innovation and creativity can foster successful and flourishing individual lives and national economies.

Through a wide array of academic and public policy programming, CPIP brings together scholars, industry leaders, inventors, artists, and policymakers to examine foundational questions and current controversies concerning patents, copyrights, and other intellectual property rights. Ultimately, CPIP seeks to promote a healthy academic discussion, grounded in rigorous scholarship, and a well-informed public policy debate about the importance of intellectual property.

For more information about CPIP, please visit our website at: http://cpip.gmu.edu.

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