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Among the main criticisms currently confronting the US Patent and Trademark Office are concerns about software patents and what role they play in the web of litigation now proceeding in the smart phone industry. While such criticisms are not new, the realm of smart phones offers an opportunity to examine the evidence on the litigation and the treatment by the Patent Office of patents that include software elements. The term "software patent" is a bit of a misnomer, since computer programming is a general purpose technology. After all, patents that claim software elements can be found in virtually every industry and a broad range of technologies.

More broadly, this article discusses the competing values at work in the patent system and how the system has dealt with disputes that, like the smart phone wars, routinely erupt over time, in fact dating back to the very founding of the United States. We present specific empirical evidence regarding the examination by the Patent Office of software patents, their validity, and their role in the smart phone wars. The article concludes with an outlook for systematic policymaking within the patent system in the wake of major recent legislative and administrative reforms. Principally, the article highlights how the US Patent Office acts responsibly when it engages constructively with principled criticisms and calls for reform, as it has during the passage and now implementation of the landmark Leahy–Smith America Invents Act of 2011.

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Constitutional Background

For more than 235 years, a national investment in the future has been part of the formal social contract of the United States, providing patent rights limited in time and scope in exchange for a full and timely disclosure of new and useful innovations. The US Constitution in Article I, Section 8, Clause 8 expressly empowers Congress to manage this investment by establishing a patent system. The constitutional design of the US patent system recognizes that the marketplace tends to undersupply knowledge, particularly when up-front costs of discovery or development are high and marginal costs of copying are low. A period of limited exclusivity is meant to provide an incentive to make such investments.

Accordingly, the revealed national preference of the United States has been to forgo some immediate economic benefit in favor of creating incentives for new generations of advances in scientific knowledge and technological application. There is a natural tendency for innovation—which requires investment for long-term benefit—to interfere with access in the form of consumption in the short term. But even in the here and now, this constitutionally protected ability of innovators in the United States to leverage their patent rights for attracting investment capital, creating jobs, and expanding into new markets reflects a preference for ensuring that individuals and small start-up firms have an opportunity to thrive and grow. To be sure, patent rights are only part of a suite of legal and nonlegal appropriability options available to innovators. Still, patents have been a useful and oft-used means of protecting innovations since the country's inception.

The Patent Office Role

The US Patent and Trademark Office's primary responsibility is to support the innovation system by examining patent and trademark applications. In the US system, patents on mechanical, electronic, and chemical technologies are generally "utility patents." Utility patent applications submitted to the Patent Office by inventors may cover processes, machines, articles of manufacture, or compositions of matter. Upon being accepted as complete, applications are given a technology classification and assigned to an examiner group. Patent examiners are specialized technology employees with training and experience in various science and engineering backgrounds related to different kinds of inventions. Examiners are also public officers who have a legal duty to grant a patent so long as the inventor has met the requirements for patentability set by Congress and the federal courts. In fact, Congress demands that "[a] person shall be entitled to a patent unless" the examiner is able to find a basis to refuse the application. To find possible bases for rejection, the examiner compares the claimed invention to the existing state of knowledge as reflected in the prior art, consisting of patent documents and the scientific and commercial literature.

Because a patent is a series of claims that define the scope of the invention, an examiner uses the results of that search to determine whether these claims delineate what the law demands: that the invention be new, useful, and adequately described and enabled. A legally sufficient claim must also be nonobvious to persons "having ordinary skill in the art" of the invention, so as to encourage inventions that will serve the cumulative advancement of technology at the frontiers of knowledge.

Through such search and examination of the application, examiners serve the public by clearing out patent claims that do not meet these legal requirements. Their labor is highly complex and knowledge-intensive, since it requires both scientific and legal understanding. In 2011, the Patent Office received over 500,000 applications.

The most fundamental and important contribution the Patent Office makes to improving the patent system involves focusing on, and investing in, higher-quality and more timely processing of patent applications (US Patent and Trademark Office 2010). In this context, "quality" refers to patent claims being clearly defined and consistently interpreted under the law, and "timeliness" encompasses a reduction in delays and pendency during examination. Both goals reduce uncertainty, and allow for more efficient investment and transactions in the market for innovation. Scholars have consistently supported these goals to improve the operation of the innovation system (National Research Council 2004).

Economic Research

This focus on reducing uncertainty—an economic concept—raises an important question about what role the patent system plays in economic growth. It is clear that a substantial share of national growth in the United States has been driven by innovation and the deployment of new technologies, which have, in turn, produced higher standards of living along with better, longer lives for people. Economists have struggled over the years to discover what role intellectual property rights play in the supply of innovation and the productivity improvements and economic growth that new technologies have ushered in. The task has been made difficult by endogeneity problems, in that patenting is correlated with other important drivers of performance. Good instruments to help us untangle this complexity are rare to nonexistent, and apart from some fine historical examples (Moser 2005), increasing international harmonization of patent laws minimizes the opportunity to observe the results of natural experiments in the real world.

That said, a body of economic research has demonstrated a positive role for patenting in economic performance. Gould and Gruben (1996), for instance, utilize cross-country data on patent protection to find that intellectual property protection is a significant determinant of economic growth. Branstetter and Saggi (2011) contribute to this general finding, showing that increased intellectual property protection in developing countries leads to more inbound foreign direct investment, a greater local production share of the global basket of goods, and higher real wages for local labor.

The mechanisms through which patent rights work to drive growth have also been a subject of research. In addition to the classical view that intellectual property rights provide an incentive to create knowledge (Arrow 1962), scholars have found that the issuing of patents is a significant determinant of commercializing inventions through licensing (Gans, Hsu, and Stern 2008). This latter view is consistent with work on the role of intellectual property rights in providing a transactional platform that facilitates a more efficient transfer of knowledge assets and gains from trade in the markets for technology (Arora, Fosfuri, and Gambardella 2004).

At the level of the firm, too, patents have been found to have an economically and statistically significant impact on firm-level productivity and market value (Bloom and Van Reenen 2002). Evidence provided by several surveys of managers at technology firms supports the notion that patents are valuable and serve a range of purposes, in preventing copying, earning profits, and engaging in effective technology competition. In a survey of research and development managers at firms across the US economy, researchers discovered that patents are widely used by firms in industry and are routinely cited as being important for profiting from innovation, although not ubiquitously so (Cohen, Nelson, and Walsh 2000). The respondents suggested that when patents were used, they served heterogeneous purposes, including protecting inventions from copying, earning licensing revenues, supporting negotiations, and enhancing reputation. A more recent survey of young technology startups basically confirmed these findings, although the respondents commonly cited the importance of building patent portfolios to facilitate inward capital investment and increasing the likelihood of successful exit events such as initial public offerings and acquisitions by other firms (Graham, Merges, Samuelson, and Sichelman 2009).

While a growing body of evidence finds that patent protection supports innovation and growth, some critics contend that the patent system should be dismantled wholesale. However, large systematic changes of the kind advocated by these critics are best interpreted in light of Oliver Williamson's (2009) "remediableness" criterion, to wit: an existing practice for which no superior feasible alternative can be described and implemented with expected net gain is presumed to be efficient. Without strong evidence of the superiority of such a large change in the institutional environment in which innovation and economic activity occurs, a "do away with patents" alternative cannot be fairly categorized as a hypothetical ideal. And even if, *arguendo*, such an alternative were hypothetically ideal, the large transaction costs associated with moving an innovation system and an economy to this new equilibrium would have to be considered in netting out the possible gains. Advocates for this view have made little progress in carrying either of these very heavy burdens.

The Patent System Has Faced and Still Faces Problems Arising from New Technologies and Uncertainty in Legal Treatment

The view that society would do better by rejecting patent incentives as both unnecessary and obstructing to knowledge consumption in the short term is closely related to criticisms that have been made regarding the patent infringement litigation of recent years among firms in the smart phone industry. Such arguments suggest that these so-called "smart phone wars" arise from overbroad and improperly issued software patents, and thus reflect flaws in patent eligibility doctrine, a too-permissive treatment at the Patent Office of software patents, and economic waste in litigation. Such criticisms are not new. They commonly reflect the recurring difficulty the patent system has experienced when facing the legal and market uncertainty associated with the eruption of discontinuous technological change.

History is a guide to us in this regard, since over time the United States patent system has been met with new challenges in technology and industrial organization, but has adapted. At times, the resolution has come legislatively, as in the 1836 patent act. Under the 1793 patent statute, patent examination was not just permissive, it was nonexistent: the Patent Office granted any patent properly applied for, leaving to society and the courts the costs of clarifying patent rights through piecemeal litigation. To mitigate the social costs, the 1836 patent act reintroduced substantive examination of patent applications for novelty and utility.

In this century, important changes in the patent law intended to deal with the demands of a changing innovation environment have occurred in 1930,[1] in 1952,[2] in 1970,[3] in 1982,[4] in 1994,[5] in 1999,[6] and again recently in the sweeping changes required in the 2011 America Invents Act (which we discuss below). Often the change has come about because of compelling factual circumstances, such as regional or national economic concerns or even the exigencies of war. Such changes have been messy and with contradiction, and often against the backdrop of patent litigation around the valuable technologies at stake. But a well-developed economic history suggests that this is what we should expect when institutional systems supporting economic activity respond to new circumstances (North 1981).

In the history of the United States, society has repeatedly celebrated seminal inventions while bemoaning the patent disputes that emerged around them. For example, Eli Whitney patented the mechanical cotton gin in 1794, ushering in huge productivity gains, but was unable to prevent wholesale infringement for many years since local juries, who resented Whitney for taking large royalties from farmers,

[1] Plant Patent Act of 1930, Pub. L. No. 71-245, 46 Stat. 376 (making patent-eligible certain new varieties of plants).

[2] Patent Act of 1952, Pub. L. No. 82-593, 66 Stat. 792 (broadly codifying and clarifying existing patent case law).

[3] Plant Variety Protection Act of 1970, Pub. L. No. 91-577, 84 Stat. 1542 (extending exclusive plant breeder rights to sexually reproduced and tuber-propagated varieties).

[4] Federal Courts Improvement Act of 1982, Pub. L. No. 97-164, Apr. 2, 1982, 96 Stat. 25. (creating the US Court of Appeals for the Federal Circuit and giving it exclusive jurisdiction over appeals both from patent litigations in the district courts and from administrative patent appeals in the US Patent and Trademark Office).

[5] Uruguay Round Agreements Act, Pub. L. No. 103-465, 108 Stat. 4809 (among other things, setting the patent term as 20 years from filing date rather than 17 years from issue date).

[6] American Inventors Protection Act, Pub. L. No. 106-113, 113 Stat. 1501 (among other things, adjusting patent term to partly compensate for certain examination delays, and requiring publication of most applications at 18 months from filing date).

would rule against him. It was not until the patent law was amended in 1800 that Whitney's legal rights were vindicated, and even then with limited economic reward.

A half-century later, when Elias Howe in 1846 patented his eye-pointed needle sewing machine, contributing to productivity gains and new economic freedoms for women, it began a period of extensive litigation among industry rivals. In response to moves like those of Isaac Singer, who tried unsuccessfully to invalidate the Howe patent, the legal landscape changed again, with the emergence in 1856 of one of the first US patent pools, in which major producers cross-licensed their mutually blocking patents. Notably, Howe was not himself a manufacturer of sewing machines, but rather a patent-holder interested in licensing his invention—by modern standards, a nonpracticing entity.

Another half-century later, Orville and Wilbur Wright patented the wing and steering designs of their flying machine, in 1906, and showed their work to the Aerial Experiment Association, founded the following year by another celebrated inventor and well-known patent litigant, Alexander Graham Bell. Having refused a license from Glenn Curtiss for his engine, the Wrights were soon mired in litigation when airplanes built by Curtiss and other industry players that infringed on the Wright brothers' steering patents met with commercial and reputational success. While the infringement dispute ended with a verdict for the Wrights, the broader business dispute was resolved only when Assistant Navy Secretary Franklin Roosevelt in 1917 pressured the rivals to allow unrestricted production of airplanes for the war effort. The scale of the dispute was larger than ever, but the lessons of the sewing machine wars had not been lost, and the airplane patents were cross-licensed through a patent pool administered by Manufacturer's Aircraft Association.

Still another half-century later, in 1957, Columbia University student Gordon Gould made some rough calculations and a sketch in his notebook of the first LASER (that is, Light Amplification by Stimulated Emission of Radiation). Gould soon left Columbia for a private research firm, and other scientists independently developed the same technology about three months after Gould, igniting a 30-year series of disputes. When Gould ultimately prevailed, the controversy over invention priority gave way to industry resistance during the 1970s and 1980s to the enforcement of Gould's patents that had been pending as applications for long periods of time. Such so-called "submarine" patents can be problematic in instances like lasers, where the patented technology becomes widely adopted across industries without firms knowing that fundamental patents exist. As before, the system righted itself, in this instance by reducing the ability of inventors to "submarine" their inventions, in 1995 by changing the measurement and length of the patent term, and in 1999 by publishing patent applications 18 months after filing.

Now, again about 50 years later after the struggles over the laser, we are embroiled in the smart phone wars. When we take the long view, this controversy does not look like a dispute for the ages, but instead a kind of controversy that has arisen periodically throughout the history of the US innovation system. The resolution of each crisis has been a refinement and reform of the patent law to meet modern needs, particularly as innovation has over time commanded increasing priority to national economic health. That same recalibration appears to be at work in how the system is dealing with smart phone patents. In fact, fair examination of the available evidence shows that the smart phone patent wars are not about low-quality software patents, nor about errors in software patent examination or issuance.

Smart Phone Wars and "Software Patents:" Some Empirical Evidence

The smart phone patent wars have produced a large number of US lawsuits involving major industry players like Samsung, Google's Motorola Mobility division, and Apple, with many counterpart suits filed overseas. Yet across these many lawsuits involving smart phones, some important questions have gone unanswered. How credible are the lawsuits? How far have these suits progressed, and how many patents are actually involved? And, given that many critics have suggested the culprit is low-quality software patents, what technologies were actually covered by the patents involved, and how did the patents fare?

In attempting to answer these questions, we examined the US patents involved in some of the high-profile litigation among four major firms in the smart phone industry: Motorola, Microsoft, Apple, and Samsung. While 133 patents were initially asserted across 13 lawsuits, a substantial share was dismissed from the cases and, as of November 2012, only 73 patents remained in controversy. A technology expert at the Patent Office reviewed these 73 patents, determining whether any of the claims could be fairly characterized as involving "software" inventions. We found that 65 of the patents included at least one software-related claim. Thus, while many of the patents asserted in the Motorola, Microsoft, Apple, and Samsung suits involved software claims, not all of the claims were to software elements, and in fact some of the patents asserted had no software elements at all. This finding is not surprising, as smart phones contain much innovation beyond software—for example, display technology, microprocessor technology, signal processing technology, signal transmission technology, and compression technology.

Of the 65 software patents still involved in this litigation, thus far only 21 of them—less than one-third—have received court decisions of the type that provide some indication of their validity or likely validity. Of those, only four patents have had decisions indicating they are invalid or likely invalid. The remaining 17 software patents evaluated so far in these cases have been declared by a court to be valid or likely valid. This 80 percent favorability ratio is not consistent with the pronouncements that the smart phone wars are being driven by low-quality software patents. In fact, this rate of validity determinations compares favorably with other technology areas. In summary, the US federal district courts, which are the principal reviewers of Patent Office decision-making, are finding in a large share of these cases that prior Patent Office examinations of the software patents involved in the smart phone litigation have been completed properly.

While that finding is positive, we were interested in digging deeper and asking other relevant questions. The recent US Supreme Court case of *Bilski v. Kappos*

(130 S. Ct. 3218 [2010]), which overturned a lower-court ruling that patents needed to involve a machine (or apparatus) and/or a transformation of an article to a different state or thing, has implications for the patent-eligibility of software and is but the latest in a series of reminders that this area of law continues to evolve. The Patent Office will continue to reassess its granting and legal treatments of patents that include software elements.

The patenting of software has created much controversy, and the underlying arguments go back long before courts in the 1980s and 1990s affirmed patent-eligibility for software and, relatedly, for patents for "business methods" (Graham and Mowery 2003). Since as early as the Morse telegraph patent disputes in the 1840s, the US patent system has grappled with abstract ideas such as mathematical principles and laws of nature on the one hand, and implementations of these ideas on the other—particularly in nascent technologies where both scientific and legal uncertainty is high. In rejecting one part of Samuel Morse's patent claim—the part concerning the use of electromagnetic power for marking characters at any distance—the US Supreme Court in *O'Reilly v. Morse* (56 US 62 [1853]) noted that Morse had described and enabled only the use of galvanic repeater circuits to preserve a signal over long distances. Without disclosing and teaching more, the Court found, his patent could not cover future applications of electromagnetic force: he could claim his way of transmitting signals, but not *signal transmission itself.*

This emphasis on knowledge diffusion and the patent *quid pro quo*, particularly in emerging and legally uncertain technological environments, has remained integral in US patent law to rewarding particular innovative solutions to problems without foreclosing the problems themselves. Similarly, the patent law leaves available to the public the intellectual tools that follow-on innovators can use to solve such problems.

In the context of software inventions, these principles have been applied by the US Supreme Court. It has denied patent-eligibility to bare algorithms for converting binary-coded decimal numbers into pure binary numerals (*Gottschalk v. Benson*, 409 US 63 [1972]) and for smoothing fluctuations in process variable trends (*Parker v. Flook*, 437 US 584 [1978]), but affirmed patent-eligibility for the physical implementation by a rubber-molding press of the Arrhenius equation (*Diamond v. Diehr*, 450 US 175 [1981]). At the Patent Office, the examining of patent applications for software-related inventions has emphasized, through exacting review of the written description and enabling disclosure of the application, that the invention as claimed must be commensurate with the invention as taught to the public.

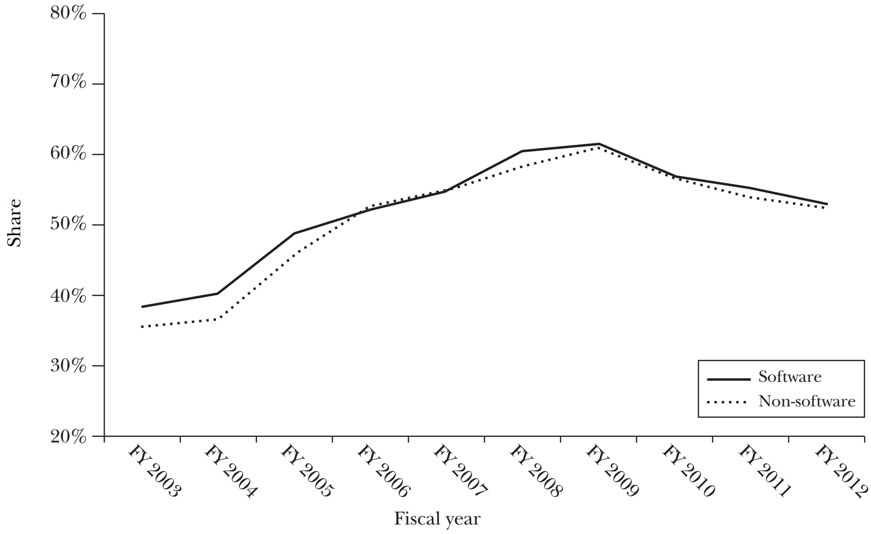
Before examining data on patenting of software inventions, first comes a definitional question: What is a software patent, and can we identify it? As any patent examiner can confirm, applications across virtually all major technology areas can include software elements, and among economic researchers, no common definition has emerged for conducting empirical analysis (Layne-Farrar 2005). Part of the difficulty stems from software having some of the characteristics of a general purpose technology. As outlined by Bresnahan and Trajtenberg (1995), these technologies are "pervasive," being widely adopted across many technologies and heterogeneous sectors in the economy. In fact, one way in which researchers measure "generality" in empirical analyses of patenting is to examine how widely adopted patents are in later, heterogeneous patented technologies (Hall and Trajtenberg 2004). Related to such pervasiveness, an accurate "software patent" definition is elusive because many patents have software elements mixed with non-software elements.

While the relatively small number of patents involved in the smart phone wars allowed us, above, to employ an expert to read the claims, that method is neither reproducible nor feasible for large-scale empirical analyses. We therefore relied on methods commonly used in the prior literature to identify "software patents," by employing patent classifications (Graham and Mowery 2003; Hall and MacGarvie 2010). Still, identifying patents with software elements can be a tricky business.

To conduct the following analyses in this paper, Patent Office experts examined all US patent classes and subclasses and determined which were likely to contain patents applications or issued patents containing some element of either general purpose software or software that is specific to some form of hardware.[7] While this definition will certainly be both over-inclusive and under-inclusive, the method is calibrated to help us identify classes in which patents with software claims are most likely to be found. As shorthand, we refer to those applications or patents which fall into these classes and subclasses as "software" applications or patents, and to those

[7] The class-subclass pairs are as follows. Class 29: Subclasses 026000-065000, 560000-566400, 650000-650000; Class 73: Subclasses 455000-487000, 570000-669000; Class 84: Subclasses 600000-746000; Class 235; Class 236; Class 244: Subclasses 003100-003300, 014000; Class 250; Class 257; Class 307; Class 315; Class 318: Subclasses 700000-832000; Class 320; Class 323; Class 324; Class 326; Class 327; Class 330; Class 331; Class 340: Subclasses 850000-870440; Class 340: Subclasses 002100-010600, 825000-825980; Class 340: Subclasses 286010-693900, 901000-999000; Class 340: Subclasses 815400-815730, 815740-815920; Class 341: Subclasses 020000-035000, 173000-192000; Class 341: Subclasses 001000-017000, 050000-172000, 200000-899000; Class 342: Subclasses 001000-465000; Class 343; Class 345: Subclasses 001100-215000, 418000-428000, 440000-472300, 473000-475000, 501000-517000, 518000-689000, 690000-698000, 699000; Class 348; Class 353; Class 355; Class 356: Subclasses 002000-003000, 004090-004100, 006000-027000, 030000-139000, 140000, 142000-151000, 153000-900000; Class 358: Subclasses 001100-003320, 260000-517000, 518000-540000; Class 359: Subclasses 326000-332000; Class 361: Subclasses 001000-270000, 437000; Class 363; Class 365; Class 367: Subclasses 001000-008000, 009000, 010000-013000, 014000-080000, 081000-085000, 086000, 087000-092000, 093000-094000, 095000-191000, 197000-199000, 900000-910000, 911000-912000; Class 368; Class 369: Subclasses 001000-032000, 043000-054000, 058000-062000, 064000, 069000-070000, 083000-095000, 097000, 100000-126000, 128000-152000, 174000-175000, 275100-276000, 300000; Class 370; Class 374; Class 375; Class 378: Subclasses 004000-020000, 210000-901000; Class 379: Subclasses 067100-088280, 188000-337000; Class 380; Class 381; Class 382; Class 385; Class 386; Class 396: Subclasses 028000, 048000-304000, 310000-321000, 373000-386000, 406000-410000, 421000, 449000-501000, 505000-510000, 529000-533000, 563000; Class 398; Class 438: Subclasses 009000, 689000-698000, 704000-757000; Class 455; Class 463: Subclasses 001000-047000, 048000-069000; Class 473: Subclasses 065000, 070000, 136000, 140000-141000, 151000-156000, 407000; Class 482: Subclasses 001000-009000, 051000-053000, 057000-065000, 069000-070000, 112000-113000; Class 600: Subclasses 001000-015000, 019000-041000, 300000-406000, 407000-480000, 481000-507000, 529000-595000, 920000-921000; Class 606: Subclasses 001000-052000, 163000-164000; Class 623: Subclasses 024000-026000; Class 700; Class 701; Class 702; Class 703: Subclasses 001000-010000, 011000-012000, 013000-999000; Class 704; Class 705; Class 706; Class 707; Class 708; Class 709; Class 710; Class 711; Class 712; Class 713; Class 714: Subclasses 001000-100000, 699000-824000; Class 715; Class 716; Class 717; Class 718; Class 719; Class 725; Class 726; Class 901; Class 902.

Figure 1
Share of US Patent Office First Final Actions that Were Rejections, FY 2003–FY 2012



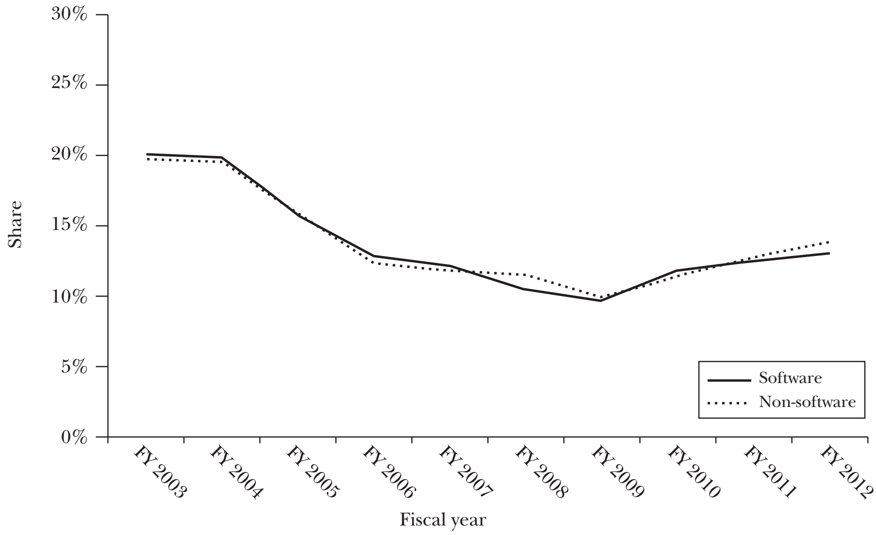
Source: Authors.
Notes: After an examiner initially rejects claims as unpatentable and the applicant responds with arguments or amendments, the examiner issues a "final action:" either an allowance or rejection. This is termed a "first final action" because the applicant may seek continued examination, leading to further iterations of nonfinal and final actions subsequent to the "first" one.

which fall outside as "non-software," with the understanding that this nomenclature is one of convenience, and will not be accurate in all cases.

Having a definition of convenience in hand, we can then proceed to some questions. How does our rejection rate for software applications compare with that of applications in the other technologies? Conversely, how does our rate of allowance on a first-action by the examiner compare with that of applications in the other technologies? How often are our examiners' rejection decisions upheld by our board of patent appeals (the principal reviewer within the Patent Office of examiners' denying patent protection)? How has our reviewing court, the US Court of Appeals for the Federal Circuit, treated our rejection decisions compared with our own board of patent appeals? In other words, when the board of patent appeals upholds examiner rejections, how does the US Court of Appeals treat those determinations?

First, as regards final rejections, the Patent Office used to reject software applications at a higher rate than non-software applications, as shown in Figure 1. Ten years ago, the rate of final rejection for software applications was 38.4 percent, 2.8 percentage points higher than for non-software applications. Over time, the final rejection rates for both software and non-software applications had risen, exceeding 60 percent by 2009. Thereafter, these rates declined to below 55 percent.

Figure 2
Share of US Patent Office First Actions that Were Allowances, FY 2003–FY 2012



Source: Authors.

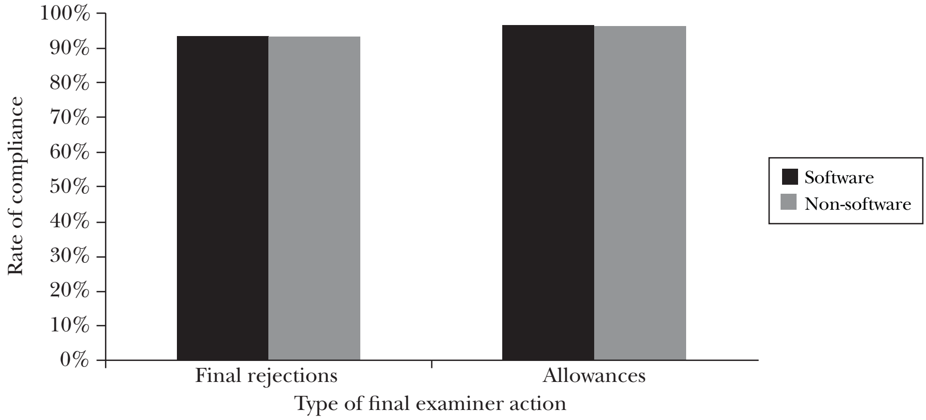
Among first final actions[8] per year from fiscal years 2003 through 2012, rejections were more likely for software applications than for non-software applications by an average difference of just 1.4 percentage points. These annual differences were significant at the 95 percent confidence interval for every year observed except 2006, 2007, and 2010. Cumulatively, rejections were more likely for software applications than for non-software applications by a difference of 2.4 percentage points, significant at the 95 percent confidence interval. The final rejection rate for software applications in 2012 is 53.1 percent, only 0.7 percentage points higher than for non-software applications, again a difference significant at the 95 percent confidence interval. Over the last decade, it appears that there has been relatively little difference in the treatment of software and non-software patent application rejections in the Patent Office.

As a comparison, we also examine the likelihood that a patent application will be allowed during the first action on the merits by the examiner during fiscal years 2003 through 2012. As illustrated in Figure 2, while first-action allowances were sometimes more, and sometimes less, likely for software patents than for non-software patents, the annual differences were small, and significant at the 95 percent

[8] After an examiner initially rejects claims as unpatentable and the applicant responds with arguments or amendments, the examiner issues a "final action:" either an allowance or rejection. This is termed a "first final action" because the applicant may seek continued examination, leading to further iterations of nonfinal and final actions subsequent to the "first" one.

Figure 3

Findings from USPTO Quality Assurance Review: Final Actions on Software and Non-software Applications, Rate of Compliance with Applicable Laws and Regulations Governing Patent Examination, FY 2007–FY2012



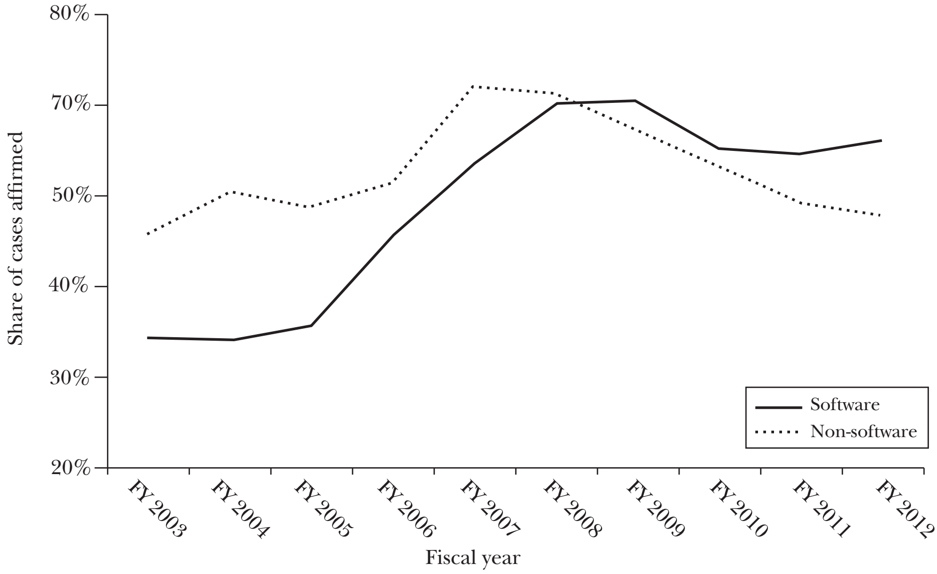
Source: Authors.

confidence interval for 2006–2008 and 2010–2012. Cumulatively during the entire period, these first-action allowances were less likely for software applications than for non-software applications by a difference of 0.5 percentage points, significant at the 95 percent confidence interval. Over the last decade, it again appears that there has been relatively little difference in the treatment of software and non-software patent application allowances in the Patent Office.

Several different explanations could account for these trends, particularly the recent decline in final rejection rates. One is that the Patent Office's focus on more compact and effective interaction between the applicant and the examiner has resulted in dispositions without the need for final rejections. Another is that guidelines, best practices, and outreach to the applicant community regarding obviousness, written description, and other examination issues have resulted in higher-quality applications being filed in the first place, a selection effect that would result in fewer final rejections.

But one explanation that the evidence does not support is that fewer final rejections reflect low-quality examination by the Patent Office. In fact, data from Patent Office internal quality assurance reviews on nearly 29,000 random examination audits over six years show that, for both software and non-software applications, the overwhelming majority of allowances and final rejections correctly apply the patent laws and examination standards. Allowances across both software and non-software applications were correctly issued over 95 percent of the time each of the last six years. Final rejections across both software and non-software applications in 2012 were correctly issued about 96 percent of the time, increasing meaningfully from 90 percent six years prior. Figure 3 shows that cumulatively, over the same

Figure 4
Affirmance of Administrative Appeals from USPTO Examiner Rejections in Software and Non-Software Applications, FY 2003–FY 2012



Source: Authors.

six years, allowances for software applications were correctly issued in 96.8 percent of cases and for non-software applications in 96.5 percent of the cases, Similarly, final rejections for software applications were correctly issued in 93.6 percent of the cases and for non-software applications in 93.5 percent of the cases. These differences in allowance and final rejection are not statistically significant, showing that software applications are being examined in the same manner as applications in all other technologies, and upon independent review, examiners are found to have correctly followed all laws and regulations in a very high percentage of the cases.

We next consider the review by the Patent Office board of patent appeals of examiner rejections during fiscal years 2003–2012, as shown in Figure 4. Data from the later years, 2008–2012, show that the board of patent appeals affirms (in whole or in part) our examiners' rejections of software applications in 57.0 percent of cases, about 2.2 percentage points higher than the rate of affirmance for denial decisions across other technologies. This share shows a narrowing of the difference between software and non-software compared with 2003–2007, when the board of patent appeals affirmed non-software rejections notably more often than software rejections, with statistically significant annual differences at the 95 percent confidence interval. In 2008, the affirmance rate for software application appeals was essentially the same as with the overall rate, and has since declined more slowly than the affirmance rate among non-software application appeals. The affirmance rate among software appeals is currently 8.2 percentage points higher than that of other technologies, significant at the 95 percent confidence interval.

As yet another institutional check on the work being completed at the Patent Office, Congress has mandated that the decisions of the board of patent appeals can be submitted for review by the US Court of Appeals for the Federal Circuit. We also examined these federal-court appeals, and while there are relatively few instances in which the US Court of Appeals has substantively evaluated the rejection of software applications, that court has upheld such rejections in over 95 percent of the cases during 2003–2012. Cumulatively, the decisions of the US Court of Appeals on cases appealed from the Patent Office board of patent appeals have not meaningfully differed as regards the review of software and non-software applications.

These data demonstrate that it is not fair to conclude the Patent Office is "soft" on software patent applications. In fact, our investigation of rejection rates shows that Patent Office software application rejections are proper, as judged by comparison to other technology areas as well as when reviewed by our board of patent appeals. Moreover, the work of Patent Office examiners is being upheld by a wide margin in the US federal courts that review their decision making.

Our analysis thus does not provide support for the statements many have made concerning the origin of the smart phone patent wars and the work of the Patent Office. But that is not to say that the US Patent and Trademark Office believes all is perfect in the world of software patents. There are things the Patent Office should address, and is addressing, principally through the implementation of the America Invents Act of 2011, the most sweeping patent reform legislation in at least a generation.

The America Invents Act as an Intervention

The America Invents Act of 2011 was the outcome of major compromise, and thus a source of both satisfaction and disappointment to all parties. Taken as a whole, the act in both substance and implementation addresses a host of issues raised by software patent critics. Among the provisions especially applicable to software inventions are the new laws enabling individuals and firms to challenge the validity of issued patents. These "post-grant" challenge options include: post-grant review, *inter partes* (or third party) review, and "covered business method" patents review. These challenge procedures are handled by a panel of administrative judges, each of whom is highly skilled in both technology and patent-law issues. Moreover, all three options are statutorily mandated to be completed in one year, thereby offering substantial cost savings over litigation and ensuring resolution of validity disputes far faster than possible in the federal courts. This speedy resolution of controversies is particularly relevant to the software industry where product life cycles are often measured in months, not years. Furthermore, the Patent Office regulations implementing all three options are built on a common streamlined platform to promote simplicity, speed, and cost-effectiveness, all critical to software innovators of any size who may want to contest patents.

In the new process of post-grant opposition, patents can be challenged on all grounds, including eligibility and clarity. The new "covered business method" review procedure will also be useful in the software area, since it allows a party actually sued, or threatened with suit on any existing business method patent (no matter how recently issued), to challenge its validity. Also, in interpreting the meaning of "business methods" under the new statute, the Patent Office has adopted an inclusive interpretation of that term to ensure that business methods implemented in software are eligible for review.

The *inter partes*, or third-party submission, allows any member of the public to participate by submitting documents and commentary for use by patent examiners. Because deep knowledge is commonly housed in the electronic records of software experts outside the Patent Office, this provision can help ensure patent examiners have access to the most relevant documents when examining software patent applications. Again, the Patent Office has implemented the third-party submission provision in a simple, streamlined, and open fashion, providing an Internet-enabled path for third parties to make submissions at no cost for the first three or fewer documents.

In these and other ways, the America Invents Act seeks to address many of the principal concerns surrounding software patent quality, approaching them in new and powerful ways. While the law continues to take effect, the Patent Office has been using the flexibility it has within its operational and regulatory scope to grant only valid software-related patents.

The Patent Office: Responsibilities and Responses

Among the core drivers of software patent quality, there are perhaps two overarching considerations: 1) the correspondence between the scope of the patent disclosure—the explanation of what was invented and how it works; and 2) the scope of the patent claims—the boundaries of the legal protection provided to the patentee. For the patent bargain to work, to incentivize rather than to inhibit innovation, legal protection must be commensurate with scope of disclosure. Otherwise, an inventor who describes only one way to solve a problem may obtain patent coverage for many ways, or all ways, to solve the problem. Worse yet, a patent that describes no clear problem and solution does society no good at all. Those who work at the Patent Office struggle every day to get this correspondence right, and see it as a primary responsibility.

While the disclosure-claim balance must be struck across all inventions in all fields, it has proven particularly difficult in the software area, where terminology has tended to shift and can be imprecise, and where functional language is frequently used to describe ideas that themselves are inherently functional in nature (leading to a kind of "generalization on generalization" phenomenon). Moreover, during the 1990s while software patent filings were escalating, the courts as well as the Patent Office were primarily focused on other parts of the patentability equation, and less on the tight correspondence between disclosure and claims.

More recently, participants in the patent system have paid renewed attention to disclosure–claim correspondence. Courts have issued a series of decisions strengthening requirements, and the Patent Office has increased the time allotted to examiners for each patent application review while providing them with the training and tools to place more focus on disclosure requirements. In a further move, the Patent Office issued specific internal guidelines focusing examiners on disclosure clarity and claim–disclosure correspondence. Patent Office review of examiner actions shows an increase in the incidence of examiners raising clarity and claim–disclosure correspondence issues. More training, measurement, and refinement is underway to ensure continued improvement.

Along with the disclosure–claim correspondence, another vital component in ensuring that only appropriate software patents are issued is the strong application by examiners of the legal doctrine of "obviousness." Obviousness governs the circumstances under which a patent applicant's claim, judged against the body of relevant prior art documents predating a patent application, is merely obvious or an advance that merits patent protection. Here again, key court decisions during the last several years have significantly changed the law in a direction enabling tighter examination practices by the Patent Office. The seminal case was the Supreme Court's decision in *KSR Int'l Co. v. Teleflex, Inc.* (550 US 398 [2007]) in which the Court rejected a narrow, rigid conception of obviousness, and instead set forth a broader set of inquiries to find whether patent claims should be treated as obvious.

The *KSR* decision, along with subsequent cases in the courts, have enabled patent examiners to consider software-related claims more carefully, taking advantage of the analogous nature of so much software and the ability of skilled programmers to draw from separate algorithms in creating new solutions. And the Patent Office has taken advantage of the heightened standard by developing appropriate examination guidelines, educating examiners to use them, and ensuring usage. The goal is to produce more technical prior art available for examiners to apply, more appropriate ways to apply it, and ultimately the granting of software patents that more accurately reflect substantial innovation.

A Systemic Approach to Patent System Health

With these changes duly noted, there remains concern about an overhang of patents that were issued in the past. While some of the provisions of the America Invents Act—such as expanded post-grant review—may help, policy advocates have made other legislative and judicial proposals. Some have called upon Congress to expand the new "covered business method review" to include software, thereby giving competitors the opportunity to use evidence that has come to light in recent years to challenge existing patents in a quick and cheap administrative hearing. Others are proposing the SHIELD Act that would adopt an English rule of cost-shifting in litigation, thus putting the cost burden of defending a suit on the loser and creating disincentives to enforce low-quality patents. Similarly, courts continue to be asked to act on issues such as enhanced scrutiny of patent claims and experimentation safe harbors, among others.

While the Patent Office has not taken an official position on these recommendations, these ongoing disputes do reflect a reality that the patent system is just that—a system. Different institutions work together to produce it. The Patent Office, constrained by available resources and laws, cannot solve all possible problems. Importantly, the Patent Office is often forced by circumstances to operate in areas of legal and technological uncertainty, like making decisions on the patentability of embryonic technologies at a point when prior art is not well developed. It routinely takes many years before the courts begin to settle legal questions, and before scientific progress resolves uncertainty about technological relationships. As history has shown, the Patent Office is routinely called upon to act before all possible bases of uncertainty are resolved.

To those who speculate on the costs of moving quickly in the face of uncertainty, economics teaches us to consider the counterfactual—we cannot know what growth and innovation would have looked like in the face of a "wait and see" approach. In this context, the biotechnology industry offers a notable example. The US moved quickly to make artificial life forms patent-eligible in the *Diamond v. Chakrabarty* decision (404 US 303 [1980]), signaling that research in emerging fields ranging from recombinant genetics to bioinformatics would be a sound investment. Other industrialized nations have spent decades trying to catch up to the growth and value that the United States created in this sector.

Conclusion

Such results reflect the ongoing balance sought by the US patent system, a balance most recently struck with the innovative reforms of the America Invents Act and the operational improvements of the Patent Office to provide more robust and transparent examination. And as the data in this article show, the recent track record at the Patent Office of examining patents containing software-related claims is an important counterweight to suggestions that the balance being struck is not appropriate. Accordingly, the smart phone patent wars, like other large-scale patent disputes in the past, may not reflect a patent system that is broken, but rather a patent system that has helped to cultivate a groundbreaking body of advances in communications technology, advances that have invited market entry by competitors. Still, just as patents are a meaningful incentive to innovate, so also is the enforcement of patents a reasonable exercise in appropriating value from innovation. That reality is at the heart of how the constitutional and legislative system of patent rights is intended to operate.

The history of the US patent system reflects a cycle of disruption—occasioned by discontinuous technological change and market adaptation in its wake—and the ensuing search for a new institutional balance. The new balance has sometimes arisen from market solutions such as cross-licensure in patent pools, or legislative solutions such as patent term reform and pre-grant publication, or judicial solutions such as revised doctrines of nonobviousness and adequate disclosure. The store of knowledge has grown, whether in textiles with the sewing machine, or in high technology with the laser, or in biotechnology with engineered bacteria. Consumers have received not merely the now-inexpensive innovations of the past, but also a reliable promise of innovation for the future. To be sure, such a commitment to the long-term benefits of innovation is a struggle against demands for access in the short term, but it is one that eventually pays for itself.

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