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## **Valuable Patents**

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## Valuable Patents<sup>1</sup>

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Patents. Inventors. The words conjure in the minds of most a vision of the solitary genius, the heroic individual – Edison, Bell, Morse – working late into the evening in a garage to perfect a device that will change the world. But while a few patents are in fact for inventions that change the world,<sup>6</sup> most are not. Inventors come up with a new idea, hire a lawyer, write a patent application, spend years in the arcane and labyrinthine procedures of the U.S. Patent and Trademark Office (PTO), get a patent, and then . . . nothing. Ninety-nine percent of patent owners never even bother to file suit to enforce their rights.<sup>7</sup> They spend \$4.33 billion per year<sup>8</sup> to obtain patents, but no one seems to know exactly what happens to most of them. Call it “The Case of the Disappearing Patents.”

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<sup>6</sup> See, e.g., Alan Cohen, *10 Patents That Changed the World*, IP WORLDWIDE, Aug. 2002, at 27 (identifying ten active patents “that have made a big difference—shaking up society for better or worse”).

<sup>7</sup> Mark A. Lemley, *Rational Ignorance at the Patent Office*, 95 NW. U. L. REV. 1495, 1501 (2001).

<sup>8</sup> See *id.* at 1499.

In the last few years, scholars have begun to pay attention to this curious phenomenon and to suggest explanations for it. Some people posit that patent owners are simply irrational – that they are leaving gobs of money on the table. Rivette and Kline argue in their book *Rembrandts in the Attic* that many valuable patents are simply overlooked by their owners.<sup>9</sup> Others suggest that many of these patents are being licensed without the patent owner ever needing to go to court,<sup>10</sup> or that the existence of the patents themselves is a sort of signaling device to consumers, competitors, venture capitalists or other investors,<sup>11</sup> or that patents are a sort of trading card that companies need in order to protect themselves from other companies with patents.<sup>12</sup> Still others have argued that the patent system is a giant lottery, with a patent the equivalent of a lottery ticket: unlikely to pay off, but very valuable if it does.<sup>13</sup> All of this work is devoted to explaining why people get patents and then don't use them, at least in the classic ways.

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<sup>9</sup> KEVIN RIVETTE & DAVID KLINE, *REMBRANDTS IN THE ATTIC: UNLOCKING THE HIDDEN VALUE OF PATENTS* (2000).

<sup>10</sup> See, e.g., Shubha Ghosh & Jay Kesan, *What Do Patents Purchase? In Search of Optimal Ignorance in the Patent Office* (working paper 2003) (assuming that most patents are used, either by being licensed or by intimidating competitors). But see Lemley, *Rational Ignorance*, *supra* note 7, at 1505 (refuting this argument). Lemley estimates that at most 3.5% of patents are licensed for revenue without a lawsuit ever being filed.

<sup>11</sup> Clarisa Long, *Patent Signals*, 69 U. CHI. L. REV. 625 (2002); Mark A. Lemley, *Reconceiving Patents in the Age of Venture Capital*, 4 J. SMALL & EMERGING BUS. L. 147 (2000). Other scholars have made a distinct and rather more limited signaling point: that patent applicants may behave strategically in patent races, using publication and even patenting of parts of a whole invention to signal their competitors or to reduce the payoff to competitor patenting. See, e.g., Gideon Parchomovsky, *Publish or Perish*, 98 MICH. L. REV. 926 (2000); Douglas Lichtman et. al, *Strategic Disclosure in the Patent System*, 53 VAND. L. REV. 2175 (2000).

<sup>12</sup> Bronwyn H. Hall and 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, 125 (2001) (discussing the royalty-free cross licensing between big patent holders that is common in the semiconductor industry and the use of patents as “bargaining chips”); Lemley, *Rational Ignorance*, *supra* note 7, at 1504-05; Kimberly A. Moore, *Xenophobia in American Courts*, 97 NW. U. L. REV. 1497 (forthcoming Summer 2003) (discussing defensive use of patents).

<sup>13</sup> F.M. Scherer, *The Innovation Lottery*, in EXPANDING THE BOUNDARIES OF INTELLECTUAL PROPERTY 3 (Rochelle Dreyfuss et al. eds 2001).

We think they are asking the wrong question.<sup>14</sup> The best explanation for why some patents are used and others are not is simple: some patents are intrinsically more valuable than others.<sup>15</sup> Many patents are not worth enforcing – either because the inventions they cover turn out to be worthless,<sup>16</sup> or because even if the invention has economic value the patent doesn't.<sup>17</sup>

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<sup>14</sup> By this we do not mean that discussion of unlitigated patents isn't useful; far from it. We simply suggest that an effort to understand the patent system should pay more attention to the small subset of patents that have proven themselves valuable.

As an aside, we think that none of the explanations offered for why people don't use their patents are entirely satisfactory. While it is surely possible that some inventors are foolishly pessimistic about the value of their inventions, it hardly seems likely that individuals and companies that have gone to the trouble of obtaining valuable patents would systematically neglect to do anything with them. Indeed, we are skeptical that inventors as a class are overly pessimistic, since they are optimistic risk seekers in other regards. Scherer, *supra* note \_\_, at 3 (discussing excessive optimism among innovators). Nor do we think that the explanation lies in the fact that companies have decided simply to get along, and happily pay licensing fees without contesting patent rights in court. While licensing without litigation certainly occurs, the best estimate is that it is limited to 3-4% of all patents. Lemley, *Rational Ignorance*, *supra* note 7, at 1507. See also Katherine Bouton, *Academic Research and Big Business: A Delicate Balance*, N.Y. TIMES, Sept. 11, 1983, §6 (Magazine), at 62, 123 (estimating that “of ten laboratory inventions, only one will receive a patent, only one in ten patents will be licensed by a company, and only one in ten licenses results in more than \$25,000 per year in income”). Further, the most significant patents – the ones that can compel license fees from an entire industry – are much more likely to be litigated. Lemley, *Rational Ignorance*, *supra*, at 1505. Even accounting for licensing without litigation leaves a giant swath of patents unaccounted for. Similarly, the other explanations for disappearing patents – that patents are used as signaling devices to impress venture capitalists or that they are used defensively to stave off suits by others, are at best only partial explanations. Start-up companies may need to obtain a patent as a financing signal, but most patent owners are large companies with no such need. See John R. Allison & Mark A. Lemley, *Who's Patenting What? An Empirical Exploration of Patent Prosecution*, 53 VAND. L. REV. 2099, 2117 (2000) (71% of patents issue to large corporations). Defensive patenting is reputedly common in some industries, notably semiconductors, but appears to be a function of the particular characteristics of those industries. See Hall & Ziedonis, *supra* note 12 (discussing cross-licensing in the semiconductor industry); Carl Shapiro, *Navigating the Patent Thicket: Cross Licensing, Patent Pools, and Standard Setting*, in INNOVATION POLICY AND THE ECONOMY (Adam Jaffe et al., eds., Nat'l Bureau of Econ. Res. 2001); cf. Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. \_\_ (forthcoming December 2003) (noting how the particular characteristics of the semiconductor industry create networks of interlocking patents). Scherer's lottery argument is persuasive in part, but as we demonstrate below, the value of patents is often evident early in the process. See *infra* notes \_\_-\_\_ and accompanying text.

<sup>15</sup> Accord Jonathan A. Barney, *A Study of Patent Mortality Rates: Using Statistical Survival Analysis to Rate and Value Patent Assets*, 30 AIPLA Q.J. 317, 329 (2002) (“A relatively large number of patents appear to be worth little or nothing while a relatively small number appear to be worth a great deal.”); Thomas Ewing, *Book Review*, 43 SANTA CLARA L. REV. 631 (2003) (“Some of the authors simply recount patent procurement and litigation statistics ad nauseum and do not seem to understand that some patents really do have no value whatsoever since no one would ever practice the disclosed technology, as claimed.”).

<sup>16</sup> The PTO issues patents on worthless inventions all the time. See, e.g., U.S. Patent No. 4,998,724 (“Thumb-Wrestling Game Apparatus With Stabilizing Handle”); U.S. Patent No. 5,031,161 (“Life Expectancy Timepiece”); U.S. Patent No. 5,076,262 (“Ear-Flattening Device”).

<sup>17</sup> This is often true if, for example, the patent claims are drafted narrowly and require for infringement the inclusion of an element that is easy to design around.

Our objective in this paper is to try to figure out what makes a patent valuable and how to identify those valuable patents. We start from the assumption that the patents that get litigated are at least a subset of the most valuable patents. We have no reason to believe that valuable patents that are not litigated differ in any systematic ways from valuable litigated patents, but this assumption is ripe for further research and testing.<sup>18</sup> We conclude that the easiest way to learn about the characteristics of valuable patents is therefore to study litigated patents. To do this, we conducted the largest, most comprehensive study of the patent system ever undertaken. We examined data on every patent that issued between 1963 and 1999 – 2,925,537 patents in all – and every patent lawsuit that terminated during 1999-2000 – 4,247 different cases covering 6,861 patents. In addition, we selected a subset of both groups for more intensive study – a random sample of 1,000 patents issued between mid-1996 and mid-1998 and 300 patents issued during that two-year period and were involved in infringement litigation that terminated during 1999-2000. We explain our study in detail in Part I. By comparing the characteristics of litigated patents, which we know to be valuable, with general patents, we can begin to understand what makes a patent valuable.

Our data conclusively demonstrate that valuable patents differ in substantial ways from ordinary patents at the time the applications are filed and during their prosecution. This suggests that valuable patents can be identified beforehand, at least in the aggregate. Some of the key characteristics of litigated patents are:

- They tend to be young, i.e. litigated soon after they are obtained.
- They tend to be owned by domestic rather than foreign companies.
- They tend to be issued to individuals or small companies, not large companies.

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<sup>18</sup> We explain and defend this assumption in Part I.A.

- They cite more prior art than non-litigated patents, and in turn are more likely to be cited by others.
- They spend longer in prosecution than ordinary patents.
- They contain more claims than ordinary patents.
- They come disproportionately from certain industries. Patents in the mechanical, computer and medical device industries are significantly more likely to be litigated than patents in the chemical and semiconductor industries.

We explain our findings in detail in Parts II through IV. Part II focuses on patents and describes the individual characteristics of valuable patents in detail. Part III broadens the focus to owners and examines whose patents are being litigated. Part IV broadens the focus still further and examines differences between industries in the value of patents.

Our examination of the characteristics of valuable patents has a number of implications for patent theory, patent policy, and patent practice. For example, the fact that value is concentrated in a few industries might suggest that the law should treat patents in different industries differently.<sup>19</sup> The fact that valuable patents are subject to a more intensive prosecution process – they have more claims, cite more prior art, and take more time to issue as patents – might suggest that the much-maligned PTO<sup>20</sup> may be doing a better job than expected in

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<sup>19</sup> For an argument along these lines, see Burk & Lemley, *Policy Levers*, *supra* note \_\_\_. On the other hand, there is a good argument that particular fields of technology, such as software, should not be the subject of *ex ante* definitions that are then used to single out certain patents for different more lenient or more stringent examination in the PTO because experienced patent attorneys often can draft patents so as to opt into or out of a definition. Patent attorneys amply demonstrated their ability to do so during the days that the status of software as patentable subject matter was in question and software inventions were often described and claimed as nuts-and-bolts inventions in the traditional physical sense. See John R. Allison & Emerson H. Tiller, *The Business Method Patent Myth*, 18 BERKELEY TECH. L.J. \_\_ (forthcoming November 2003).

<sup>20</sup> For criticism of the job the Patent and Trademark Office does in evaluating patents, see, e.g., Julie E. Cohen, *Reverse Engineering and the Rise of Electronic Vigilantism: Intellectual Property Implications of “Lock-Out” Programs*, 68 S. CAL. L. REV. 1091, 1177-80 (1995); Andy Johnson-Laird, *Looking Forward, Legislating Backward?*, 4 J. SMALL. & EMERGING BUS. L. 95, 120-24 (2000); Jay P. Kesan & Marc Banik, *Patents as Incomplete Contracts: Aligning Incentives for R&D Investment With Incentives to Disclose Prior Art*, 2 WASH. U. J.

evaluating the patents that really matter – or it might mean that patent examiners are buried in paper by those critical applications. These identifiable indicia of value, importance, or likelihood of litigation also provide insight that could help target PTO reform efforts. The fact that patents issued to individual inventors and small companies are more likely to be litigated has several possible implications for patent policy, depending on how the data are interpreted. Finally, the existence of objectively verifiable predictors of the value of a patent should revolutionize the “black art” of patent valuation.<sup>21</sup> We discuss these and other implications of our findings in detail in Part II.

## **I. What We Did**

### **A. Why We Equate Litigation and Value**

We begin by articulating and defending a major assumption in this paper – that litigated patents are valuable patents. We believe the relationship is quite strong and bidirectional – that litigated patents tend to be much more valuable than others on average, and that valuable patents are much more likely than others to be litigated.<sup>22</sup> While not every valuable patent is necessarily

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L. & POL’Y 23 (2000); 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); John R. Thomas, *Collusion and Collective Action in the Patent System: A Proposal for Patent Bounties*, 2001 U. ILL. L. REV. 305 (2001) (hereinafter *Bounties*); Simson Garfinkel, *Patently Absurd*, WIRED, July 1994, at 104; James Gleick, *Patently Absurd*, N.Y. TIMES, Mar. 12, 2000, § 6 (Magazine), at 44; Lawrence Lessig, *The Problem With Patents*, INDUSTRY STANDARD, Apr. 23, 1999, available at <http://www.thestandard.com/article/display/0,1151,4296,00.html>; Greg Ahronian, *Patenting the Internet, electronic commerce, bioinformatics*, at <http://www.bustpatents.com/index.html>; Jeff Bezos, *An Open Letter on the Subject of Patents*, <http://www.amazon.com/exec.obidos/subst/misc/patents.html>.

<sup>21</sup> Patent valuation has historically been uncertain. See Frank Russell Denton & Paul J. Heald, *Random Walks, Non-Cooperative Games, and the Complex Mathematics of Patent Pricing* (working paper 2003) [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=385843](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=385843) (criticizing the general approaches to patent valuation).

<sup>22</sup> The only alternative explanation, that litigation is not a good predictor of value, strikes us as implausible. Litigation is far more costly than merely obtaining a patent. If litigation does not indicate that a patent is valuable, it means that litigants are systematically irrational in selecting patents to enforce. While such a conclusion is possible, given the indirect inferences that characterize most of the measures of patent value offered to date, we are skeptical that any of those measures is stronger evidence of value than litigation itself.

litigated, we believe the relationship is strong enough to justify the conclusion that litigated patents are a good proxy for valuable patents.<sup>23</sup>

At the outset, it may help to be clear what we mean when we speak of valuable patents, so the reader can see what we are *not* arguing. First, when we speak of valuable patents we are referring to the value of the patent, not of the invention it protects. Many valuable inventions were never patented, or were covered only by ineffective patents.<sup>24</sup> Those inventions may be valuable, but the patents are not. Second, we refer to private rather than social value. The key question is whether the patent owner finds the patent valuable, not whether the patent in question contributes to social welfare. Indeed, some of the patents most valuable to their owners may turn out to impose significant costs on society as a whole. Third, we are talking about patents that *turn out* to be valuable. We do not intend to suggest that individuals or companies who applied for other patents necessarily made a mistake or acted irrationally.<sup>25</sup> It may make perfect sense *ex ante* to apply for a patent even though *ex post* that patent turns out to be worthless. Fourth, we are examining the value of individual patents, not patent portfolios. A company like IBM with tens of thousands of active patents may be able to obtain substantial licensing revenue,<sup>26</sup> but that doesn't mean that any particular IBM patent is valuable. Rather, people may be paying because of the "killer patent portfolio."<sup>27</sup> Finally, we should also be careful to distinguish value

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<sup>23</sup> To make this assertion, we must also demonstrate that litigated patents are a representative subset of valuable patents.

<sup>24</sup> Several important examples include the television, the computer, the personal computer, and the Internet.

<sup>25</sup> Some did, undoubtedly. The owner of the patent for the Hyperspeed Light Antenna, U.S. Patent No. 6,025,810, for instance, could not have rationally expected to recoup his costs of prosecution.

<sup>26</sup> IBM reportedly collects over \$500 million per year in patent licensing fees. [http://www.informationholdings.com/lps\\_files/market.html](http://www.informationholdings.com/lps_files/market.html).

<sup>27</sup> See Willard K. Tom, *The 1975 Xerox Consent Decree: Ancient Artifacts and Current Tensions*, 68 ANTITRUST L.J. 967 (2001).



from breadth. While it is intuitive that broader patents are more valuable than narrower ones, even a narrow patent that is properly placed can have significant value, sometimes more than a broader patent covering a wide swath of a less lucrative or less developed field. Thus, one reason that citations received may correlate so highly with litigation is that it is evidence that a patent was an early entrant in a field now crowded with competitors. That fact does not imply that the patent is broad – indeed, it may suggest the opposite – but it makes the patent potentially very valuable in excluding those competitors. By “valuable patents,” in short, we mean individual patents that produce substantial economic benefit to their owners.

The intuitive case for the litigation-value connection begins with the highly asymmetric distribution of observable patent value. The majority of patent owners do not even bother to pay the relatively modest “maintenance fees” necessary to keep their patents in force, suggesting that more than half of all patents are not worth even a few thousand dollars a decade later.<sup>28</sup> On the other hand, patent litigation is extremely expensive. The legal fees alone for the median patent case cost \$1.5 million per side in 2001,<sup>29</sup> and that does not take into account either the higher mean (because some cases cost much more) or the other costs in expert fees, lost employee productivity, and uncertainty. A rational patent owner won’t file suit unless his expected return is at least a few million dollars.<sup>30</sup> Based on this evidence, patent values are not normally

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<sup>28</sup> Jean O. Lanjouw et al., *How to Count Patents and Value Intellectual Property*, 46 J. INDUS. ECON. 405 (1998). Maintenance fees are due in increasing amounts at periods 3 ½ years, 7 ½ years, and 11 ½ years after the patent issues. 35 U.S.C. § 41(b) (West Supp. 2000). The fees are \$830 at 3 ½ years, \$1,900 at 7 ½ years, and \$2,910 at 11 ½ years. 35 U.S.C. § 41(b). Those fees are halved for small entities. *Id.* Lemley collects data showing that 2/3 of all patents expire for failure to pay maintenance fees. Lemley, *Rational Ignorance*, *supra* note \_\_, at 1504 Table 3.

<sup>29</sup> See AMERICAN INTELLECTUAL PROPERTY LAW ASSOCIATION, REPORT OF ECONOMIC SURVEY 2001, at 84-85.

<sup>30</sup> This is not to suggest that all raw patent damage awards in litigated cases are likely to be in excess of several million dollars. See Kimberly A. Moore, *Judges, Juries and Patent Cases – An Empirical Peek Inside the Black Box*, 99 MICH. L. REV. 365, 395 Fig 6 (2000) (finding that the damage awards granted by judges and juries exceed \$1 million in about 50% of the cases). The raw damage award may be supplemented with attorneys fees or enhanced for willful infringement. Moreover, the damage award is often less valuable to the patentee than the injunction which accompanies it.

distributed. Most patents are worth very little to their owners – not even enough to pay maintenance fees. Litigated patents are by definition worth several orders of magnitude more than the majority of patents. While litigated patent may not be the *most* valuable patents -- an issue we discuss in a moment – they are more valuable than the overwhelming number of unlitigated patents.

There is also strong empirical support for the litigation-value connection. A number of scholars have found that patent litigation correlates strongly with value.<sup>31</sup> Of course, because these studies treat litigation as a dependent variable, by necessity they posit some other measure of value, and those measures may themselves be flawed. Regardless any argument about patent value needs to have some baseline with which to define patent value. And the baselines identified so far turn out to correlate rather strongly with litigation.

One possible objection to the story we have told would concede that litigated patents are valuable, but deny that they are the *most* valuable patents. Litigation, on this account, is evidence of weakness in a patent. Perhaps competitors quietly take licenses to the *truly* valuable patents, and the ones they fight about are a sort of “upper-middle class” of potentially valuable

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<sup>31</sup> See, e.g., Lanjouw & Schankerman, *Characteristics of Patent Litigation: A Window on Competition*, 32 RAND J. Econ. 129 (2001) [hereinafter Lanjouw & Schankerman, *Characteristics of Patent Litigation*]. **[Authors: Need pinpoint cite] [No, we don't need a pincite because the entire article stands for this proposition]** (finding that litigation correlates with patent value); Lanjouw & Schankerman, *Enforcement*, *supra* note 363651, at 4 (“more valuable patents . . . are much more likely to be involved in suits”); Dietmar Harhoff et al., *Citations, Family Size, Opposition and the Value of Patent Rights*, (working paper 1999) (studying German patents and finding that the most valuable patents are those that have survived a validity challenge, which in Germany is an administrative opposition procedure); Stuart J.H. Graham et al., *Post-Issue Patent “Quality Control”: A Comparative Study of US Patent Re-Examinations and European Patent Oppositions*, NBER Working Paper No. 8807 (2002) (same); Dietmar Harhoff & Markus Reitzig, *Determinants of Opposition Against EPO Patent Grants – The Case of Biotechnology and Pharmaceuticals*, working paper (May 2000). Cf. Jean O. Lanjouw & Josh Lerner, *The Enforcement of Intellectual Property Rights: A Survey of the Empirical Literature*, 49/50 ANNALES D'ECONOMIE ET DE STATISTIQUE 223-246 (January/June 1998) (surveying the literature on the issue).

but less-than-perfect patents. This is a variant on the Priest-Klein hypothesis about the selection of disputes for trial.<sup>32</sup>

We have no direct way to evaluate this argument, but we are skeptical that there is a large class of extremely valuable but never-litigated patents or that its characteristics differ in systematic ways from those of litigated patents. Our study identifies any patent on which a lawsuit was filed. This measure is likely to include many if not all of the most valuable patents. Several factors impel us to this conclusion. First, not every dispute need end in litigation for a patent to show up in our study. A patentee may seek license fees from many different defendants; if even one of them puts up a fight, that dispute will end up in court and therefore in our study. Second, patentees need not intend to take a suit to trial for the case to appear in our study. Patentees (or accused infringers) may file a lawsuit as a negotiating tactic or to preserve their rights, even if they expect to settle the dispute quickly. Those suits are included in our study as well. Third, while legal fees are expensive in real terms, their cost drops in percentage terms the more valuable a patent is. Parties arguing over a patent worth \$1 million in damages may have little incentive to litigate their claim, since the cost of litigation will eat up much of the surplus. But parties arguing over a patent worth \$100 million in damages will go to court if they differ even slightly over the value of the patent in question. These factors lead us to doubt the existence of a sizeable class of extremely valuable but never-litigated patents.

Regardless of how many valuable but not litigated patents exist, there is no evidence or intuitive reason to believe that the characteristics of valuable litigated patents which we identify and measure in this article would differ in any significant way from the characteristics of

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<sup>32</sup> George L. Priest & Benjamin Klein, *The Selection of Disputes for Litigation*, 13 J. LEGAL STUD. 1, 4-5 (1984). It is important to note that Priest and Klein do not directly support the argument made in text. Their paper discusses what makes lawsuits go to trial or settle; our study addresses the question of what lawsuits will be filed in the first place.

valuable, but not litigated patents.<sup>33</sup> We conclude that litigated patents are valuable to their owners and that although not all valuable patents are litigated, we believe that litigated patents are a subset of valuable patents and analysis of their characteristics can shed light on value.

We acknowledge, however, that the litigation-value connection is an important and controversial assumption. If you don't believe any of the explanations we've offered here, however, all is not lost. Take the paper, cross out "Valuable Patents" in the title, and write in "Litigated Patents." Our findings in Part II may still be of interest to you, though you may find our policy conclusions there suspect because they depend on the assumption that the PTO should spend the most time examining the patents most likely to be litigated. Our findings in Parts III and IV will not be affected.

## **B. How We Compared Litigated and Non-Litigated Patents**

Most prior studies of the patent system, including our own, have focused either on issued patents<sup>34</sup> or on litigated patents.<sup>35</sup> For this study it was important to compare the two.<sup>36</sup> The

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<sup>33</sup> We acknowledge that it is possible that valuable unlitigated patents could have different characteristics from valuable litigated patents, but it seems unlikely to us. For example, it is possible that while valuable litigated patents have significantly more claims (mean of 19.6) than issued patents that are not litigated (mean of 13.0), valuable unlitigated patents may not share this same characteristic. However, all things being equal, patents with more claims cost the patentee more money to draft, more money to file, and more money to prosecute. It therefore seems likely that patentees would spend this additional money on patents they believe to be more valuable at their filing or perhaps having spent this extra money in fact makes the patent more valuable. Either way, it seems unlikely that valuable unlitigated patents would have systematically fewer claims than valuable litigated patents.

<sup>34</sup> For studies on the characteristics of issued patents themselves, see, e.g., Allison & Lemley, *Who's Patenting What*, *supra* note [Error! Bookmark not defined.](#); John R. Allison & Mark A. Lemley, *The Growing Complexity of the U.S. Patent System*, 82 B.U. L. REV. 77, 139-41 (2002). There is also a substantial literature on valuation of intellectual property and its role in R&D by reference to different economic indicators. See, e.g., John Bound et al., *Who Does R&D and Who Patents?*, in R&D, PATENTS AND PRODUCTIVITY 21 (Zvi Griliches ed. 1984); Zvi Griliches et al., *R&D, Patents and Market Value Revisited: Is There a Second (Technological Opportunity) Factor?*, 1 ECON. INNOV. & NEW TECH. 183 (1991); Zvi Griliches, *Patent Statistics as Economic Indicators: A Survey*, 28 J. ECON. LIT. 1661 (1990); Zvi Griliches et al., *The Value of Patents as Indicators of Inventive Activity*, in ECONOMIC POLICY AND TECHNOLOGICAL PERFORMANCE 97 (Partha Dasgupta & Paul Stoneman eds. 1987); Adam B. Jaffe & Manuel Trajtenberg, *International Knowledge Flows: Evidence from Patent Citations*, 8 ECON. INNOV. & NEW TECH. 105 (1999); Bronwyn H. Hall, Adam B. Jaffe & Manuel

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Trajtenberg, *Market Value and Patent Citations: A First Look* 13-22 (Nat'l Bureau of Econ. Research, Working Paper No. 7741, 2000) (articulating a citation-weighted patent valuation analysis); Jean O. Lanjouw et al., *How to Count Patents and Value Intellectual Property: The Uses of Patent Renewal and Application Data*, 46 J. INDUS. ECON. 405, 407-18 (1998) (reviewing the methodology used to evaluate patent application and renewal data as evidence of innovation); Jean O. Lanjouw & Mark Schankerman, *The Quality of Ideas: Measuring Innovation With Multiple Indicators*, NBER working paper No. 6297 (1999); Mark Schankerman & Ariel Pakes, *Estimates of the Value of Patent Rights in European Countries During the Post-1950 Period*, 96 ECON. J. 1052 (1986) (attempting to value patents in Europe).

<sup>35</sup> The empirical literature on litigated patents includes GLORIA K. KOENIG, PATENT INVALIDITY: A STATISTICAL AND SUBSTANTIVE ANALYSIS (rev. ed. 1980); John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 AIPLA Q.J. 185 (1998); Moore, *Judges, Juries and Patent Cases*, *supra* note \_\_; John R. Allison & Mark A. Lemley, *How Federal Circuit Judges Vote in Patent Validity Cases*, 27 FLA. ST. U. L. REV. 745 (2000); Kimberly A. Moore, *Forum Shopping in Patent Cases: Does Geographic Choice Affect Innovation?*, 79 N.C. L. REV. 889 (2001); Kimberly A. Moore, *Are District Court Judges Equipped to Resolve Patent Cases?*, 15 HARV. J. L. & TECH. 1 (2001); Christian A. Chu, *Empirical Analysis of the Federal Circuit's Claim Construction Trends*, 16 BERKELEY TECH. L.J. 1075 (2001); Jean O. Lanjouw & Josh Lerner, *Tilting the Table? The Predatory Use of Preliminary Injunctions*, 44 J. L. & ECON. 573 (2001); Jean O. Lanjouw & Josh Lerner, *The Enforcement of Intellectual Property Rights: A Survey of the Empirical Literature*, NBER Working Paper No. 6296 (1997); Kimberly A. Moore, *Jury Demands: Who's Asking?*, 17 BERKELEY TECH. L.J. 847 (2002).

<sup>36</sup> Of the few works to compare the characteristics of issued and litigated patents, Lanjouw and Schankerman's work stands out. *See, e.g.*, Lanjouw & Schankerman, *Characteristics of Patent Litigation*, *supra* note 43; Jean O. Lanjouw & Mark Schankerman, *An Empirical Analysis of the Enforcement of Patent Rights in the United States*, (working paper 2002). Their work is important, but it by no means exhausts the field. Lanjouw and Schankerman construct a matched-pair sample of litigated and non-litigated patents to compare the characteristics of those patents. Their data is old, dealing primarily with patents filed between 1980 and 1984. As we do, Lanjouw and Schankerman find some significant differences between litigated and non-litigated patents. There are a number of limitations in their study, however, that our work overcomes. First, our data is much more recent. Second, Lanjouw and Schankerman's definition of areas of technology is coarse. It includes only four different technologies, and those are defined by reference to 4-digit IPC codes. They also rely on IPC codes as definition of a patent's breadth. Lanjouw & Schankerman, *Characteristics of Patent Litigation*, *supra* note 43, at 142. As we show *infra* notes \_\_\_-\_\_\_ [Part II.A.1.e] and accompanying text, these IPC codes are unreliable both for defining technology areas and as a measure of patent value. This led Lanjouw and Schankerman to some strange results, which they erroneously concluded to reveal that patents touching upon more technology areas are less valuable. *See id.* Our definition of industries is much more nuanced. Their study also lacks data on non-patent prior art citations, on small entity status, and on post-issue assignment of the patent, all of which we find to be key differences between litigated and non-litigated patents. Finally, their study relies only on litigated patents which are reported to the PTO and reported in the Derwent Lit Alert database. This is less than 50% of all patents actually litigated; more importantly, reporting to the PTO is not systematic or consistent done by all jurisdictions. For example, their database, which spans 21 years of litigation, only examines 9,345 patents. Our database, which includes all litigation in a 2 year period, includes 6,861 patents. As Kimberly Moore has shown, there are substantial differences in how different district courts resolve patent cases which could affect their data. *See Moore, Forum Shopping in Patent Cases*, *supra* note ~~363654~~, at 907-20. Our database in contrast, is the entire population of district court litigations and every patent at issue therein.

Another important work which compares issued and litigated patents is a forthcoming study of the difference in U.S. patents acquired by foreign and domestic inventors. Moore, *Xenophobia*, *supra* note 12 (identifying significant differences between the characteristics of litigated and issued patents to domestic and foreign inventors).

authors are uniquely situated to do so. Kimberly Moore collected a comprehensive database containing every patent lawsuit filed in the United States that terminated during 1999-2000.<sup>37</sup> John Allison and Mark Lemley collected and intensively studied a random sample of 1,000 patents issued between mid-1996 and mid-1998.<sup>38</sup> To find out what distinguishes valuable litigated patents from ordinary issued patents, we extracted some additional data from the sample of 1,000 patents and then combined our databases.

Our “study” actually consists of two separate studies: a large population study and a sample study. The large population study is more comprehensive. We compared *all* issued U.S. patents from 1963 through 1999 (2,925,537 patents in total) with *all* patents for which a lawsuit was filed in any federal court<sup>39</sup> that terminated during 1999-2000 (6,861 patents in total). We obtained the issued patent data from Bronwyn Hall’s publicly-available database.<sup>40</sup> That database permitted us to determine for each patent what type of entity (individual, foreign corporation, US corporation, or government) owned the patent when it was filed, the number of citations to U.S. patent prior art made in the patent, the number of citations to the patent made by subsequent U.S. patents, the number of claims in the patent, the number of inventors and their nationality, and a rough classification of the industry to which the patent belonged.

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<sup>37</sup> For descriptions of this database, see, e.g., Moore, *Xenophobia*, *supra* note \_\_\_\_.

<sup>38</sup> See Allison & Lemley, *Who’s Patenting What?*, *supra* note [Error! Bookmark not defined. Error! Bookmark not defined.](#)<sup>17</sup>; Allison & Lemley, *Growing Complexity*, *supra* note [343449](#).

<sup>39</sup> Jurisdiction over patent infringement lawsuits is exclusive in federal court. 28 U.S.C. § 1338.

<sup>40</sup> See Bronwyn H. Hall, Adam B. Jaffe & Manuel Trajtenberg, *The NBER Patent Citations Data File: Lessons, Insights and Methodological Tools*, NBER Working Paper No. W8498 (October 2001). Their database is available at <http://www.nber.org>.

To make sure that the issued patent and litigation data were comparable, we had to impose a couple of controls.<sup>41</sup> First, the characteristics of U.S. patents have changed dramatically over time.<sup>42</sup> A simple comparison of all issued patents to all litigated patents would therefore be misleading, because the characteristics of patents issued in different years tend to differ. To solve this problem, we determined when each of the litigated patents issued. We then weighted the issued patent data so that it was comparable to the litigated patents.<sup>43</sup> In other words, if 1% of the litigated patents were issued in a given year, our study gives issued patents from that year 1% of total weight. The distribution of litigation rate by patent age is presented in Figure 1 in the Appendix.<sup>44</sup> Second, because the database includes patents that vary widely in age, and because citation patterns have changed over time, we normalized the measure of citations to the patent by other patents within each year.<sup>45</sup> The older a patent is, the more opportunity other patents have to cite to it as prior art. If we did not use this normalized

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<sup>41</sup> Several omissions from the data must be acknowledged. First, the litigated patents database contained litigation involving design and plant patents that were excluded for all comparison purposes. The litigated cases also involved some reissue patents (137 reissue patents). For these patents we manually collected the characteristic data. Finally, the NBER database only covered 1963-1999, and had limited data available for patents issued before 1975. In the litigated database which includes cases terminated in years 1999-2000, 65 of the patents involved in these cases actually issued in year 2000. Because there were no issued patents in the NBER database for the year 2000, they are excluded from the comparison. There are also some cases of missing information for particular patents. These data issues are not thought to be systematically related to patent characteristics in a way that would affect our analysis, however.

<sup>42</sup> Allison & Lemley, *Growing Complexity*, *supra* note [343449](#) (revealing many changes in the characteristics of issued patents from the late 1970s to the late 1990s); Hall, Jaffe & Trajtenberg, *NBER*, *supra* note \_\_\_ (finding that patent citation and claiming practice has changed over time).

<sup>43</sup> When comparing population means between litigated and issued patents, we weight the issued patents according to their relative proportion of litigated to issued patents by year. When performing multivariate analysis, we explicitly model age as an explanatory variable.

<sup>44</sup> As Figure 1 reveals, the peak litigation rate occurs when patents are 3 years old. Age is measured from grant date to the end of the year that the litigation terminated. If, instead, we had measured grant date to litigation filing date, we would expect the peak litigation rate to be substantially less than 3 years.

<sup>45</sup> For a discussion of the means of normalizing citation counts, see Hall, Jaffe & Trajtenberg, *NBER*, *supra* note \_\_\_, at 25-37.

measure, the age of the patent would swamp real differences in the number of citations made to the patent.

The large population study provides definitive information on certain differences between issued and litigated patents. The limitations of the NBER patent database, however, make it difficult to evaluate some of the important characteristics of valuable patents. To overcome those limitations, we conducted a second, more intensive study of a smaller sample of both litigated and issued patents. This “sample study” compares the characteristics of 1,000 randomly selected patents that issued between June 1996 and May 1998 with the characteristics of 300 patents randomly selected from the 1,200 that issued during the same period and that were the subject of infringement litigation terminating during 1999-2000. Because we individually reviewed each of the patents in the sample study, we were able to evaluate a number of variables that we could not consider in the large population study. The additional variables we have included in the sample study include prior art citations not just to U.S. patents, but to foreign patents and non-patent prior art; the nationality of the patent owners; whether the patent owner qualified for “small entity” status in the PTO; and a much more accurate and nuanced assessment of the area of technology into which the invention falls.<sup>46</sup>

In short, the large population study allows us to learn a few facts about an extremely large number of patents, with the total statistical confidence in the results that comes from a population study rather than a sample. The sample study allows us to investigate many more

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<sup>46</sup> On the rather striking limitations of the PTO classification scheme for determining area of technology, and for a full description of the technology areas we defined in the sample study, see Allison & Lemley, *Who's Patenting What*, *supra* note [Error! Bookmark not defined. Error! Bookmark not defined. 17](#), at 2114.



details about a smaller set of patents, and to use the rules of statistical inference to predict the characteristics of the larger universe of issued and litigated patents.<sup>47</sup>

For both studies, we collected data about each of the variables of interest in both the litigated and issued patent populations. This allows us to compare those two populations on any specific measure – say, the average number of claims in each group of patents. For the large population study, we can make those comparisons directly. For the sample study, we used statistical techniques to assure us that the differences in the samples were statistically significant – that is, that the differences between the samples were not due to chance.<sup>48</sup>

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<sup>47</sup> All of the results we report are statistically significant at a 99% or greater confidence level unless otherwise noted.

<sup>48</sup> We first used bivariate statistical techniques to compare the attributes of our sample of 300 litigated patents with those of our sample of 1,000 unlitigated patents. The type of test varied, depending on the nature of the distribution for each attribute. Variables such as number of references, number of claims, number of years the patents spent in the PTO, and several others had means that were heavily influenced by extreme upper outliers, *i.e.*, the distribution was substantially skewed to the right. Logarithmic transformation of the values in such cases caused the distributions to be much closer to normal. Log-transformed means were then compared using independent-groups *t*-tests. In each instance, we also used a Wilcoxon nonparametric test as an additional check to make sure that when we reported significant differences, they were truly significant.

Variables such as number of inventors, number of International Patent Classifications (IPCs) into which patents were placed, number of technology areas involved in each patent, and several others were characterized by Poisson distributions. A Poisson distribution is generally found in the case of infrequent events. In other words, when the absolute numbers are relatively small, and the range among these values is rather narrow, it is a Poisson distribution. In the instance of variables such as these, a Chi-squared test was used. *See, e.g.*, P. MCCULLAGH & J.A. NELDER, *GENERALIZED LINEAR MODELS 2* (2d ed. 1989) (generally describing the Poisson distribution).

In the case of categorical (“dummy” or “dichotomous”) variables where the attribute is simply “yes” or “no,” we used a z-test for independent proportions. In other words, in the case of variables such as whether or not a patent was owned by an individual, small business, or large business, we compared the proportions that either did or did not possess that attribute in the sample of litigated patents and the sample of unlitigated patents.

We then built a regression model in which we selected the most important patent characteristics and treated them as independent variables. In other words, these were the “predictor” variables. Status of a patent as either litigated or unlitigated was the dependent or “outcome” variable. The value of using a multivariate technique such as this is that it takes into account the interactions among independent variables, that is, the influence that some independent variables have on each other. The regression tells us, for example, whether the total number of claims remains as a significant predictor of litigation after taking account of the correlation between other variables (such as the number of references) and the number of claims.

Because many variables may be related – different industries may tend to cite more prior art, for example, and citing more prior art may lead to longer times in prosecution<sup>49</sup> – we also ran a multiple regression analysis for both the large population study and the sample study. The results of the Logit regressions<sup>50</sup> are reported in Tables 4 and 5 in the Appendix for the large population study and the sample study respectively. In both the population and sample studies, the multiple regression analysis revealed that the differences between litigated and unlitigated patents we identified remained significant after accounting for the influences that many variables within each group had upon each other.

## II. Measuring Patent Value

By virtually any measure, litigated patents differ in statistically significant ways from issued patents.<sup>51</sup> We examined a variety of different characteristics of both litigated and issued patents. These characteristics fall into three basic categories: the nature of the patent itself, the nature of the applicant, and the nature of the industry. In this section and the two that follow, we present our findings and consider the implications for patent policy. We begin by comparing our

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<sup>49</sup> On these relationships see Allison & Lemley, *Who's Patenting What*, *supra* note [Error! Bookmark not defined. Error! Bookmark not defined.](#) 17, at 2130-32 & Table 13 (prior art citations vary by industry).

<sup>50</sup> Logit models are used when the dependent variable is binary such as whether the patent was litigated or not. The result of such a model will be a predicted probability of litigation based upon the characteristics of a particular patent. See G.S. MADALLA, LIMITED DEPENDENT AND QUALITATIVE VARIABLES IN ECONOMETRICS 22-28 (1983).

For the large population Logit analysis, we have treated patents with litigation terminating in 1999 and those with litigation terminating in 2000 as two separate observations on whether a patent was litigated in a year. Then, separately for 1999 and 2000 litigation terminations, we matched these litigated patents to all patents granted between 1963 and 1999. For each of these two groups, we then defined the dependent variable to be equal to 1 if the patent had litigation that terminated in that year and zero otherwise. The two groups are then merged for analysis. The result of the logit model applied to a patent with particular characteristic can then be interpreted as the probability that the patent will be litigated in a year. To obtain the probability that the patent would be litigated across its lifetime, one need only add up all of the probabilities at each year of age. This corresponds to vertically adding all of the bars in Figure 1 in the appendix.

<sup>51</sup> We are not suggesting that our results prove that the different characteristics cause litigation; rather we believe that the differences in patent characteristics and litigation rate are both indicators of patent value.

empirical results regarding patent value to a variety of prior efforts to identify valuable patents.<sup>52</sup> We then discuss three results that have great significance for patent policy: the fact that litigated patents received a more searching examination in the PTO than issued patents generally;<sup>53</sup> the fact that patents issued to individuals and small businesses are much more likely to be litigated than those issued to large companies;<sup>54</sup> and the fact that patent litigation is more significant in some industries than others.<sup>55</sup>

### A. Testing Scholarly Predictions of Value

Economists have sought to measure patent value for a long time.<sup>56</sup> Knowing which patents are valuable is important in litigation because it can help determine damages.<sup>57</sup> It is important to businesses because it can help value assets and determine the wisdom of mergers and license deals, and because it can provide an actuarial basis for a robust patent insurance market.<sup>58</sup> And value is important to policy analysis of the patent system, because it can help us distinguish important from frivolous or merely run-of-the-mill patents, and to design our patent policy to give greater emphasis to more important patents.<sup>59</sup>

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<sup>52</sup> See *infra* section II.A.

<sup>53</sup> See *infra* section II.B.

<sup>54</sup> See *infra* section III.

<sup>55</sup> See *infra* section IV.

<sup>56</sup> See Hagelin, *supra* note \_\_ (discussing patent valuation)

<sup>57</sup> Patent damages are based either on lost profits attributable to the patent, or on the reasonable royalty a licensee would be expected to pay. 35 U.S.C. § 284. Both of these measures, particularly the royalty rate to be charged, depend on the value a patent has.

<sup>58</sup> See Hagelin, *supra* note \_\_, at \_\_.

<sup>59</sup> See Lemley, *Rational Ignorance*, *supra* note \_\_ (making this argument).

## 1. Traditionally Evaluated Factors

Many of the existing measures of market value are derived from logical but untested hypotheses about the significance of measurable facts about issued patents. Six such measures stand out in the literature. First, some scholars have suggested that the number of claims<sup>60</sup> in a patent is evidence of its breadth, and therefore of its value.<sup>61</sup> Second, scholars have argued that the number of references cited in a patent (sometimes referred to as “citations made” or “backward citations”) is evidence of a patent’s likely validity and therefore of its value.<sup>62</sup> Third,

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<sup>60</sup> A patent’s claims are the legal definition of the invention. In order to decide whether a patent is infringed, a court must compare the claims of the patent to the defendant’s device. *See generally* Markman v. Westview Instruments, 517 U.S. 370 (1996).

<sup>61</sup> *See, e.g.,* Lanjouw & Schankerman, *Characteristics of Patent Litigation*, *supra* note 43, at 140-42. *Cf.* Allison & Tiller, *Business Method Patent Myth*, *supra* note 30, [how do I provide a pincite for article not yet published?] (reviewing the literature on numbers of claims as an indicator of patent value). The number of claims in a patent can be affected by a number of factors. At first blush, it would appear that two of the authors themselves have disagreed slightly in the past about the significance of the number of claims as a predictor of value. *Compare* Allison & Tiller, *Business Method Patent Myth*, *supra* note 30, at -- (arguing that claims are one indicator of patent value) *with* Allison & Lemley, *Growing Complexity*, *supra* note 343449, at 104 (the number of claims can reflect “resource constraints, drafting style, uncertainty about the law or the significance of an invention, or a host of other factors that are not necessarily driven by patent value”). There is no disagreement in substance, however; Allison & Tiller simply argue that the number of claims is an indicator of patent value, and Allison & Lemley note that the number of claims may also be affected by factors unrelated to value. Also, the quote from Allison & Lemley with respect to number of claims possibly reflecting resource constraints does not recognize something we later learned, namely, that the commitment of greater resources to obtaining patents with more claims may itself make them more valuable in many cases. Thus, there is agreement among the authors on the basic proposition that the average number of claims in a set of patents is related to patent value. Kimberly Moore has stated elsewhere that “The theory that the number of patent claims in a granted patent correlates to patent breadth makes little intuitive or logical sense, however.” *Xenophobia*, *supra* note 12, at \_\_. Her only complaint is with the practice of economists in equating the number of claims with patent “scope.” All of us agree that this is wrong conceptually and terminologically. The scope of a patent is a function of the reach of a particular claim, not the number of claims. Moore is in agreement with the proposition that the number of claims is a value indicator.

<sup>62</sup> The theory is that the more citations that are considered during prosecution by the examiner, the less likely it is that some prior art exists that will invalidate the patent. The more prior art considered, in other words, the more thorough the review. *See, e.g.,* Moore, *Xenophobia* *supra* note 12, at \_\_ [AUTHOR: Please provide pincite] (arguing that “patents that include more citations or more diverse citations are more likely to be valid”); Allison & Tiller, *Business Method Patent Myth*, *supra* note 30, at \_\_ [AUTHOR: Please provide pincite] (arguing that there is a correlation between the number of prior art references and patent value); Harhoff et al, *Citations, Family Size*, *supra* note \_\_ (finding a relationship between prior art references cited and other measures of patent value). *But see* Lanjouw & Schankerman, *Characteristics of Patent Litigation*, *supra* note 43, at 138 (failing to find a statistically significant relationship between citations to US patent prior art references and patent litigation). Unlike Lanjouw and Schankerman, our study finds a statistically significant relationship between prior art citations and litigation.

some have claimed that the number of “citations received” – references made by subsequent patents to the patent of interest – is evidence of the importance other inventors accord the patent, and is therefore evidence of its significance.<sup>63</sup> Fourth, Hall, Jaffe and Trajtenberg have identified a measure they call “generality,” which is a means of calculating the dispersion of citations received across different patent classes and which they argue is a measure of patent breadth – and therefore patent value.<sup>64</sup> Fifth, Hall, Jaffe and Trajtenberg have also identified a measure they call “originality,” which is a means of calculating the dispersion of citations *made* across different patent classes and which they argue is a measure of the importance of the invention.<sup>65</sup> Finally, Lanjouw and Schankerman among others have used the number of different International Patent Classifications (IPCs) into which an invention is put by the PTO as evidence of both the breadth and originality of an invention, and hence as evidence of its value.<sup>66</sup>

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The larger dataset of our large population study, and the fact that our sample study includes all prior art references, not just U.S. patent references, may explain the difference.

<sup>63</sup> A number of studies have used forward citations as evidence of patent value. *See, e.g.*, Bronwyn H. Hall et al., *Market Value and Patent Citations: A First Look*, NBER working paper No. W7741 (1998); Hall, Jaffe & Trajtenberg, *NBER*, *supra* note \_\_, at 14; Dietmar Harhoff et al., *Citation Frequency and the Value of Patented Inventions*, 81 REV. ECON. & STAT. 511 (1999); Manuel Trajtenberg, *A Penny for Your Quotes: Patent Citations and the Value of Innovations*, 21 RAND J. ECON. 172 (1990). *Cf.* Lanjouw & Schankerman, *Characteristics*, *supra* note [363654](#), at 130 (finding that citations received predicted litigation when those citations were made by competitors); Barney, *supra* note [151520](#), at 345 Figure 8 (finding that citations received were positively related to patentee decisions to pay maintenance fees).

<sup>64</sup> Hall, Jaffe & Trajtenberg, *NBER*, *supra* note \_\_, at 21; *see also* Manuel Trajtenberg, Adam Jaffe & R. Henderson, *University versus Corporate Patents: A Window on the Basicness of Invention*, 5 ECON. INNOV. & NEW TECH. 19 (1997). They define generality as a function of the sum of the percentages of citations received in each patent class. Hall, Jaffe & Trajtenberg, *NBER*, *supra* note \_\_, at 21 (explaining that “if a patent is cited by subsequent patents that belong to a wide range of fields the measure will be high, whereas if most citations are concentrated in a few fields it will be low”).

<sup>65</sup> Hall, Jaffe & Trajtenberg, *NBER*, *supra* note \_\_, at 21. They define originality as a function of the sum of the percentages of citations made to U.S. patent prior art in each patent class. *Id.*

<sup>66</sup> *See, e.g.*, Lanjouw and Schankerman, *Characteristics of Patent Litigation*, *supra* note 43, at 142 (as noted at *supra* note 48, however, their reliance on IPCs to conceptually define technology areas led them to the erroneous conclusion that the number of different technology areas touched upon by patents was inversely related to value); Josh Lerner, *The Importance of Patent Scope: An Empirical Analysis*, 25 RAND J. ECON. 319 (1994) (using the number of subclasses as a proxy for breadth and finding that broader patents are more valuable). Other scholars have rejected the use of IPC codes, however. *See, e.g.*, Harhoff et al., *Citations, Family Size* *supra* note \_\_, at \_\_;

Most of these measures have been developed for use with issued patents in general.<sup>67</sup> Our study allows us to evaluate the efficacy of these measures by seeing how well they predict the likelihood of litigation. Since litigated patents are a representative subset of valuable patents,<sup>68</sup> the measures that have been offered as predictors of value should, if accurate, also predict litigation. Some, but not all, of the value measures used by economists pass this test.

We find that the first three measures listed above are unambiguously strong predictors of patent litigation.<sup>69</sup> The more claims, prior art citations made, and citations received a patent has,

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Jean O. Lanjouw & Mark Schankerman, *Stylized Facts of Patent Litigation: Value, Scope and Ownership*, NAT'L BUREAU OF ECON. RES. WORKING PAPER NO. 6297 (1997) [hereinafter Lanjouw & Schankerman, *Stylized Facts of Patent Litigation*] (finding that the average number IPCs is *not* correlated with propensity to litigate); Dominique Guellec & Bruno Van Pottelsberghe de la Potterie, *The Value of Patents and Patenting Strategies: Countries and Technology Areas Patterns*, 11 ECON. INNOVATION & NEW TECH. 133 (2002) (finding that issued patents actually were characterized by a *smaller* average number of 4-digit IPCs than abandoned or rejected applications, which were presumably less valuable than issued patents); Dominique Guellec & Bruno Van Pottelsberghe de la Potterie, *Applications, Grants, and the Value of Patent* (sic), 69 ECON. LETTERS 109-14 (2000), available at <[http://www.ulb.ac.be/cours/solvay/vanpottelsberghe/resources/Pap\\_Econ\\_letters\\_1.pdf](http://www.ulb.ac.be/cours/solvay/vanpottelsberghe/resources/Pap_Econ_letters_1.pdf)> (same).

<sup>67</sup> There are other ways of measuring patent value. For instance, one recent paper measures the breadth of a patent by counting the words in each independent claim, under the plausible hypothesis that shorter claims are broader. Barney, *supra* note 151520, at 342 Fig. 5; accord Jesse Giummo, *Should All Patentable Inventions Receive Equal Protection? Identifying the Sources of Heterogeneity in Patent Value* (working paper 2002). Similarly, others have used retrospective measures such as payment of maintenance fees to measure value. See Jean O. Lanjouw, *Patent Protection in the Shadow of Infringement: Simulation Estimates of Patent Value*, 65 REV. ECON. STUD. 671 (1998) (correlating payment of renewal fees in Germany with litigation); Ariel Pakes & Margaret Simpson, *Patent Renewal Data*, 1989 BROOKINGS PAPERS ON ECON. ACTIVITY: MICROECONOMICS 331; Mark Schankerman & Ariel Pakes, *Estimates of the Value of Patent Rights in European Countries During the Post-1950 Period*, 96 ECON. J. 1052 (1986). For still other measures, see Ted Hagelin, *A New Method to Value Intellectual Property*, 30 AIPLA Q.J. 353 (2002) (describing the existing cost, market, and income methods of valuation, and proposing basing a calculation of value on a complex of factors); Russell F.R. Denton & Paul J. Heald, *Random Walks, Non-Cooperative Games, and the Complex Mathematics of Patent Valuation*, working paper 2003 (constructing a finance-based measure of value akin to the Black-Sholes equation); Deepak Somaya, *The Influence of Firm Strategies and Litigation Tactics on the Length of Patent Suits*, working paper 2003 (suggesting that the more valuable the patent is to the patentee, the longer it will take to settle a case); Hall et al., *Market Value*, *supra* note \_\_ (using the number of countries in which a patentee seeks protection as a measure of value); Giummo, *supra*, at 1 (measuring the value of German patents based on records of compensation paid to employee-inventors under German law). We do not discuss these measures further in this paper because our study does not provide the data with which to evaluate them. We note, however, that many of these measures, such as maintenance fees and Hagelin's estimate of high-value patents, only become available long after patent prosecution is complete.

<sup>68</sup> See *supra* section I.A. If litigated patents are not a representative sample of valuable patents, then the measures do not predict value but do predict litigation.

<sup>69</sup> In the large population study, the only factors that had no significant affect on litigation were a patentee's status as a foreign individual or a foreign government. See Table 4 attached. The regression model compared each of the types of patent owners (US individual, foreign individual, US corporation, foreign corporation, US government and

the more likely it is to be litigated. We found that litigated patents have a much more involved prosecution process than issued patents generally. In the sections that follow, we discuss our findings in detail.

**a. Patent Claims**

Litigated patents include significantly more claims than issued patents: 19.6 claims on average for litigated patents, compared with 13.0 claims for issued patents.<sup>70</sup> Of course, the fact that this measure predicts litigation does not mean that the stories told to explain the relationship between the number of claims and litigation are accurate. For example, the number of claims bears no necessary relation to the breadth of a patent. Indeed, if anything the relationship should

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foreign government) to unassigned patents. Hence, patents owned by foreign individuals and foreign governments are not significantly different from unassigned patents in terms of their likelihood of being litigated. In the sample study, each of the variables we discuss in text differed significantly between litigated and non-litigated patents. The following variables were not statistically significant predictors of litigation in our multivariate regression analysis: number of total US applications filed, non-profit status, years in the PTO, number of inventors, number of dependent claims, number of patent references, patent family size, 4-digit IPC counts, and the medical device, computer related, software, and semiconductor technology measures. See Table 5 attached. It is important to note that, when we simply compared each variable in the litigated patent data set with its counterpart in the general patent data set, we found very significant differences in most of these variables. The reason these differences disappeared in the multivariate regression is that the multivariate regression analysis takes into account any interactions among the tested variables, and the correlations that exist among several of them caused their individual significance to diminish. To take just one example, litigated patents spent much more time in the PTO than non-litigated patents, but time spent in the PTO is quite significantly correlated with the number of U.S. applications filed in a family chain (e.g., continuations). Thus, the fact that time in the PTO does not show up as an independent predictor of litigation in the multivariate regression analysis should not obscure the fact that litigated patents clearly spent more time in the PTO than other patents. Indeed, when we ran an alternative multivariate regression that omitted the number of U.S. applications filed, years in the PTO became a highly significant predictor of litigation. When we omitted the number of U.S. applications filed, the size of the patent family also became a significant predictor of litigation. We define patent family size as the total number of patents that ultimately issued from the original application in a chain. Building regression models requires the exercise of much judgment, and the number of applications filed arguably should have been omitted because it signaled much of the same information as other variables, particularly patent value size.

<sup>70</sup> The data from the sample study show the same statistically significant difference, but higher mean numbers: 14.87 claims for non-litigated patents, and 25.46 claims for litigated patents ( $p < .0001$ ). The difference may reflect the fact that the sample study measures more recent patents – those issued between 1996 and 1998. Hall, Jaffe & Trajtenberg, *NBER*, *supra* note \_\_, at 24 (finding that the number of claims across all patents has risen over time); Allison & Lemley, *Growing Complexity*, *supra* note [343449](#), at 103-04 & Tables 6A-6B (same). *Cf.* Barney, *supra* note [151520](#), at 341 Figure 4 (showing a relationship between the number of independent claims and the likelihood that a patentee will pay maintenance fees).

be inverse: the closer the patent is to the prior art, and therefore the narrower it is, the more claims a patentee may draft in order to help preserve the patent's validity.<sup>71</sup>

Nonetheless, because claims are costly to draft, file and prosecute, a willingness to spend money on more claims suggests that the patentee values a multi-claim patent at least somewhat more than a patent with few claims.<sup>72</sup> A more plausible explanation is that litigated patent applicants anticipated the possibility of litigation *ex ante* and drafted more claims in order to make their patent stronger in litigation. If this hypothesis is correct, it suggests that litigated patents have more claims than average because their owners anticipated the prospect of litigation – that is, that the owners knew at the time of prosecution that these patents would turn out to be important ones.

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<sup>71</sup> This is particularly true of dependent claims, which cannot add to the breadth of independent claims and are only used as hedges against the invalidity of an independent claim. In the sample study, we found a significant positive relationship between litigation and the number of *both* independent and dependent claims. Litigated patents had 4.44 independent claims and 21.03 dependent claims on average, while non-litigated patents had only 2.75 independent and 12.12 dependent claims. These results were statistically significant ( $p=.0011$  for independent claims and  $p=.0044$  for dependent claims).

<sup>72</sup> As Kimberly Moore has argued,

The theory that the number of patent claims in a granted patent correlates to patent breadth makes little intuitive or logical sense, however. A patentee could file a patent with a single very broad claim or 50 narrow claims. According to some economists, the second patent (with 50 claims) would be 50 times broader than the single claim patent, but the correct interpretation easily could be the reverse. Drafters of patents sometimes file many narrow claims *because* they cannot succeed with a single broad claim. It is thus impossible a priori to determine whether the difference between patents with 15 claims on average and those with 12 claims on average indicate that one set or the other is narrower. There is thus no reason to believe that the number of claims in a given patent varies in any consistent way with patent scope, or with the likelihood of patent enforcement efforts.

Perhaps the most that can be said about data on the number of claims is that the number may correlate with patent value. Filing more claims costs an applicant more money. The minimum PTO application fee covers twenty claims (three independent and seventeen dependent). If the applicant wishes to submit more than twenty claims or more than three independent claims, she must pay an additional per claim fee. The PTO fees are, moreover, pennies compared to the attorney expenses associated with patent drafting and prosecution. Prosecuting a patent application averages from \$10,000 to \$30,000. The bulk of such expenses are spent drafting and prosecuting the claims, so more claims will raise prosecution fees.

Moore, *Xenophobia supra* note 12, at \_\_ [AUTHOR: Please provide pincite](citations omitted).

It is conceivable that the number of claims reflects nothing more than an agency cost problem – that lawyers are simply jacking up their fees by writing more complex patents. The fact that litigated patents have more claims than non-litigated patents tends to undermine this cynical explanation, however. There is no reason to believe that litigated patents are more likely to be subject to agency cost problems than non-litigated patents.



## b. Prior Art Citations Made

Litigated patents also cite significantly more prior art than issued patents. The large population study tested citations to other U.S. patents; litigated patents cited 14.20 U.S. patents on average, while issued patents cited only 8.43 U.S. patents on average.<sup>73</sup> While some of this difference no doubt results from the fact that litigated patents are disproportionately domestic, and domestic inventors are more likely to cite U.S. patents than foreign inventors,<sup>74</sup> the multivariate regression analysis confirms a strong relationship between prior art citations and litigated patents even controlling for nationality.

The NBER data collected in the large population study count only one type of prior art reference – U.S. patents. Because citations to foreign patents and particularly to non-patent prior art may be quite significant to the validity of a patent,<sup>75</sup> in the sample study we not only

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<sup>73</sup> When normalized as Hall, Jaffe & Trajtenberg suggest, *see* Hall, Jaffe & Trajtenberg, *NBER*, *supra* note \_\_, at \_\_, the large population study data show that litigated patents cite 1.59 times as many U.S. patents as issued patents.

The mean numbers in the sample study show the same variation between litigated and non-litigated patents, but higher absolute values: 10.34 US patent references for non-litigated patents and 22.80 US patent references for litigated patents (p=.0001). As with the number of claims, this likely reflects the increased tendency to cite prior art over time. *See* Allison & Lemley, *Growing Complexity*, *supra* note [343449](#), at 101-03 & Tables 5A-5B.

<sup>74</sup> *See* Allison & Lemley, *Who's Patenting What?*, *supra* note [Error! Bookmark not defined. Error! Bookmark not defined. 17](#), at 2137; Allison & Lemley, *Growing Complexity*, *supra* note [343449](#), at 132; Moore, *Xenophobia* *supra* note 12, at \_\_.[AUTHOR: Please provide pincite]

<sup>75</sup> Commentators have argued that particularly in industries such as software and business methods, non-patent references are the best source of prior art. *See, e.g.*, Julie E. Cohen, *Reverse Engineering and the Rise of Electronic Vigilantism: Intellectual Property Implications of "Lock-Out" Programs*, 68 S. CAL. L. REV. 1091, 1177-80 (1995); Greg Aharonian, *Legal Resources and Tools for Surviving the Patenting Frenzy of the Internet, Bioinformatics and Electronic Commerce*, INTERNET PATENT NEWS SERVICE, <http://www.bustpatents.com> (arguing that software patents are of doubtful validity because they cite very little non-patent prior art). *See generally* John R. Thomas, *Collusion and Collective Action in the Patent System: A Proposal for Patent Bounties*, 2001 U. ILL. L. REV. 305, 316-22; 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) (discussing the problems the PTO has in finding and applying prior art). *But see* Allison & Tiller, *Business Method Patent Myth*, *supra* note 30, at – [pincite for yet-unpublished article?]? (detailed statistical analysis of large data set of Internet business method patents finding that these patents cite slightly more patent prior art, far more non-patent prior art, and far more total prior art than the average patent and than patents in most other technology areas).

compared the number of citations to prior U.S. patents, but also to foreign patents, non-patent prior art references, and total prior art references. The results are reported in Table 1. Litigated patents cite significantly more U.S. patents, total patents (including foreign patents), non-patent references, and total prior art references than non-litigated patents.<sup>76</sup> Although litigated patents did cite more foreign patents (considered apart from references to total U.S. and foreign patents combined) than did non-litigated patents, the difference was statistically significant only at the 90% and not the 95% confidence level. One would expect litigated patents to cite substantially fewer foreign patents as prior art, because although foreign patentees acquire 45% of all U.S. patents annually, they sue to enforce their patents in 13% of the cases.<sup>77</sup> Foreign patentees are more likely to cite foreign prior art likely because geography affects the spillover of technology.<sup>78</sup> Indeed, given this difference, the fact that litigated patents likely cite more foreign patents is particularly remarkable. It suggests that applicants perceiving more value devote more resources to getting stronger patents, and that these efforts translate into greater actual value. It may also suggest that litigated patents have counterparts prosecuted in many countries, another fact which suggests those patents are considered more valuable.

**Table 1**

Citation Counts in Sample Study

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<sup>76</sup> The high level of significance shown by the p-values for all of these variables except citations to foreign patents were confirmed by Wilcoxon nonparametric tests. The non-significance of the difference in citation to foreign patents was also confirmed by Wilcoxon tests.

<sup>77</sup> Moore, *Xenophobia*, *supra* note \_\_, at \_\_.

<sup>78</sup> *Id.* at \_\_ (proving that foreign patentees cite more foreign prior art and discussing the literature on geographic spillover).

Outcome	Non-Litigated Patent Mean	Litigated Patent Mean	Log Transformed Non-Litigated Patent Mean	Log Transformed Litigated Patent Mean	Unequal Variance P value
NumUSPatentReferences	10.34	22.80	1.96	2.60	.0000
NumForeignPatentReferences	2.44	3.53	1.09	1.25	.0696
NumTotalPatentReferences	12.79	26.32	2.19	2.70	.0000
NumNonPatentReferences	2.37	8.32	1.16	1.84	.0000
NumTotalReferences	15.16	34.64	2.35	2.93	.0000
CitationsReceived	1.34	3.45	0.65	1.06	.0000

Additionally, the large population study shows that propensity to self-cite is a significant predictor of litigation.<sup>79</sup> Self citations are citations made to other patents also owned by the same assignee during prosecution. Litigated patents cite more prior art owned by the same assignee than non-litigated patents. The empirical results support our intuition – when patent owners acquire numerous patents on a given technology it suggests that the technology is more valuable to them. This intuition is confirmed again by the relationship between litigation and the number of related patents having issued from the same original application as the patent in the dataset, which we refer to as a patent family.<sup>80</sup> Similarly, patents are likely to cite a great deal of prior art when patent applicants anticipate litigation and are trying to make their patent as strong as possible.<sup>81</sup> As with claims, the relationship between the number of citations and litigation suggests that patent applicants know in advance which patents are likely to be litigated. Moreover, patents with a large number of cites may end up in litigation with greater frequency because they are issuing in a crowded field (as evidenced by the large number of cites). Hence,

<sup>79</sup> While there is a significant difference between litigated and non-litigated patents with regard to self-citations made, there is none with regard to self-citations received. Hence, a patent is not more likely to be litigated if in the future more patents owned by the same assignee cite it.

<sup>80</sup> See *infra* notes \_\_\_-\_\_\_ [Part II.A.2.a] and accompanying text.

<sup>81</sup> The alternative explanation is that the patent office happens to be finding more prior art for litigated cases. Allison and Lemley debunk this explanation. See Allison & Lemley, *Growing Complexity*, *supra* note \_\_\_, at 132-33.

for these patents there is more competition in the field and accordingly more opportunity for infringement.

**c. Citations Received**

The differences between litigated patents and ordinary patents extend beyond prosecution. They also affect what happens to the patents once they issue. Patents that end up being litigated are much more likely to be cited as prior art by other issued U.S. patents than are non-litigated patents. Ordinary patents received 4.32 citations on average from other patents during the period of our large population study, while litigated patents received 12.23 citations from other patents. Indeed, the number of citations received has a particularly strong association with litigation. In the sample study too, citations received is by far the strongest predictor of litigation except for individual and small entity status.

**d. Generality and Originality Indexes**

By contrast to claims and citations, the other three measures economists have used do not fare so well in predicting litigation.<sup>82</sup> While there are differences between litigated and non-litigated patents in both generality and originality as defined by Hall, Jaffe & Trajtenberg, those differences are minor in comparison to other factors. Litigated patents have a generality index of 0.36 on average, compared with 0.30 for non-litigated patents.<sup>83</sup> Similarly, litigated patents have an originality index of 0.41 on average, compared with 0.37 for non-litigated patents. Neither factor significantly predicts litigation, which calls into question their utility as measures

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<sup>82</sup> We described those measures *supra* notes \_\_\_ - \_\_\_ [Part II.A.1 intro] and accompanying text.

<sup>83</sup> Even this small difference overstates the predictive significance of generality, since the small standard deviation for litigated patents (0.07) compared with non-litigated patents (0.27) means that in a significant number of cases non-litigated patents will actually rate higher than most litigated patents on the generality index.

of value. Given that these measures rely on the number of different U.S. patent classes of the cites, which is a flawed means of separating by technology, this is not surprising.

**e. Patent Classifications**

The final measure, number of patent classifications, is more complex. The sample study definitively refutes the idea that the number of different classes into which a patent falls in either the U.S. PTO or International Patent Classification (IPC) systems is significantly correlated with litigation. Indeed, there is no statistically significant relationship between either the number of U.S. PTO patent classifications or the number of 4-digit IPC classifications and the likelihood of litigation.<sup>84</sup> The relationship between the number of narrower 9-digit IPC classifications is statistically significant but *negative*. In other words, contrary to the theory that the number of classifications is a measure of value, the data actually suggest that non-litigated patents have somewhat more 9-digit IPC classifications (1.58 for non-litigated patents on average, compared with 1.44 for litigated patents).<sup>85</sup> Thus, the number of patent classifications into which patents have been placed cannot be used as a measure of patent value.

Interestingly, however, we did find a significant correlation between the average number of technology areas we defined and hand-coded in our sample study and the likelihood of litigation.<sup>86</sup> Litigated patents fit into an average of 1.99 of the 14 technology areas, while non-litigated patents fit into 1.59 different areas.<sup>87</sup> Thus, the intuition behind measuring classifications as evidence of breadth is a good one. But the existing classification systems do

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<sup>84</sup> Chi-square p values = .1844 for U.S. classifications and .0902 for 4-digit IPCs.

<sup>85</sup> This results is statistically significant (p=.0285).

<sup>86</sup> Allison and Lemley have explained how they reviewed each patent and sorted it into one or more of 14 technology areas in order to overcome the shortcomings of the IPC classifications in defining areas of technology. See Allison & Lemley, *Who's Patenting What*, *supra* note \_\_, at 2109-12.

<sup>87</sup> This difference was statistically significant (p<.0001).

not capture any significant amount of that breadth because they were designed for totally different purposes. They were never intended to provide conceptual delineations of technology areas, but instead identify inventions by function at very low levels of abstraction in order to serve as aids to prior art searching.<sup>88</sup> If economists want to measure patent breadth, they will have to hand-code the patents by technology area or at least find a better measure than the ones that exist today.<sup>89</sup>

## 2. New Factors

In addition to the characteristics identified in the literature, we found several additional factors that were significant predictors of litigation. In this section, we discuss two such factors.

### a. Families of Applications and Patents

Litigated patents were the result of a more involved prosecution process than issued patents. The patent application process permits applicants who cannot persuade an examiner to issue a patent to file an unlimited number of “continuation” applications, effectively getting repeated chances to persuade the examiner to grant the patent.<sup>90</sup> Applicants can also file “continuation-in-part” (CIP) applications that add new information or inventions to the existing

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<sup>88</sup> See Allison & Tiller, *Business Method Patent Myth*, *supra* note 616176, at \_\_ [AUTHOR: Please provide **pincite**] (further discussing the inadequacy of existing PTO and International Patent Classification schemes for identifying technology areas).

<sup>89</sup> Because patent offices use these classification systems to assign applications to examiners, evidence of persistent problems with the classification system also casts some doubt on whether patent applications are really being assigned in the most efficient fashion.

<sup>90</sup> See 35 U.S.C. §120.

application. And applications that originally claim more than one invention will be separated into “divisional” applications and prosecuted separately.<sup>91</sup>

Patent applicants whose patents were ultimately litigated filed many more continuation applications than ordinary applicants – an average of 0.72 per litigated patent, compared with 0.24 for issued patents in our sample study. They also filed more CIP applications: 0.60 per litigated patent, compared with 0.18 on average for issued patents. They were more likely than issued patent owners to abandon their original applications and prosecute the continuation – even more direct evidence of an effort to “wear down” the examiner and persuade her to grant a patent.<sup>92</sup> And their applications were more likely to be the subject of divisional filings: 0.25 per litigated patent on average, compared with 0.11 per non-litigated patent.<sup>93</sup> The overall result is that each litigated patent resulted from an average of 2.57 different applications, compared with 1.54 applications per issued patent.<sup>94</sup>

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<sup>91</sup> For a detailed discussion of the use of these various mechanisms, see Cecil D. Quillen, Jr., et. al, *Continuing Patent Applications and Performance of the U.S. Patent and Trademark Office – Extended*, 12 FED. CIR. B. J. 35 (2002).

<sup>92</sup> Litigated patents had an average of 0.73 ancestor applications abandoned, compared with 0.32 abandoned applications for issued patents. Cf. Barney, *supra* note 151520, at 333 (finding a relationship between the number of continuation applications and the likelihood that a patentee will pay maintenance fees, another common measure of value in the economic literature).

<sup>93</sup> While divisional applications result from restriction requirements imposed by the PTO, see 35 U.S.C. §120, and therefore would not appear to be within the control of the patentee, anecdotal evidence from patent prosecutors indicates that some patent applicants intentionally file broad applications in order to provoke a restriction requirement. Thus, the number of divisional applications is at least partially within the control of the patent applicant in some cases.

Interestingly Graham and Mowery find that continuation applications as a group tend to cover less rather than more valuable patents, a result seemingly at odds with our finding that continuation applications are more likely to result in litigated patents. Stuart J.H. Graham & David C. Mowery, *Submarines in Software? Continuations in U.S. Software Patenting in the 1980s and 1990s*, \_\_ ECON. INN. & NEW TECH. \_\_ [AUTHOR: Please provide source and citation info](forthcoming 2003). When they break the data down, however, the results suggest that continuation applications and CIPs are positively related to patent value, while divisionals are negatively related to patent value. We think this is largely consistent with our findings in the text, which are weighted heavily towards continuations and CIPs.

<sup>94</sup> All these differences are statistically significant ( $p < .0001$ ).

Litigated patents also tended to be part of “families” of issued patents.<sup>95</sup> While in some cases multiple applications result from serial efforts to convince the PTO to issue a single patent, continuations and CIPs can also reflect a company’s desire to build a platform of related patents.<sup>96</sup> To test this, we measured the total number of patents that had issued in the family – that is, based on the same original single application that supported the patent in our sample study. Litigated patents were part of a family of 1.85 patents on average, while non-litigated patents had a family size of only 1.22.<sup>97</sup>

As these empirical results demonstrate, it has become quite common to leave a continuation “open” at the patent office in order to maintain claims to an early priority date.<sup>98</sup> Although reissue practice allows the filing of broader claims within two years of a patent’s

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<sup>95</sup> Our definition of “family” differs from that in Lanjouw & Schankerman, *Characteristics*, *supra* note [363654](#), at 130, who use the term to refer to the number of countries in which a patentee has chosen to file. *Cf.* Barney, *supra* note [151520](#), at 344 Figure 7 (demonstrating a relationship between number of countries in which the patentee sought protection and a patentee’s willingness to pay maintenance fees). What they refer to as the size of a patent family is actually a measure of the geographic scope of patent coverage for the same invention. This metric intuitively should reflect patent value, but it should not be referred to as a patent family. By contrast, we are using the term in a more precise patent law sense, to refer to multiple patents that issue in the United States traceable to the same original application, referred to as the “parent” or “grandparent” application.

<sup>96</sup> See generally Carl Shapiro, *Navigating the Patent Thicket: Cross Licensing, Patent Pools, and Standard Setting*, in *INNOVATION POLICY AND THE ECONOMY* (Adam Jaffe et al., eds., Nat’l Bureau of Econ., 2001) [hereinafter Shapiro, *Thicket*]. See also James Bessen, *Patent Thickets: Strategic Patenting of Complex Technologies* (working paper 2002).

<sup>97</sup> This difference is statistically significant ( $p < .0001$ ). In fact, this is not a complete measure of the number of patents in the family, because it reflects only those patents issued through September 1, 2002. Because patent applications were kept confidential during the period of our study, there is no way to tell whether other applications from the same family are still pending. However, this fact makes no difference for our purposes, since it is equally true of litigated and non-litigated patents. Further, since more than four years had elapsed between the end of our sample period and September of 2002, and since family members are as likely to have issued before the studied patent as after it, it is likely that we have identified most of the family members of the studied patents. It should be emphasized, however, that we were not content to simply count the number of patents from the same original application that were listed on the face of a subject patent at the time it was issued by the PTO. For each related application noted on the patent under study for which there was no indication that it had either been abandoned or had resulted in a separate patent on a closely related invention, we traced the application serial number to ascertain what had happened to it in the more than four years since the subject patent had issued.

<sup>98</sup> See Mark A. Lemley, *Abolishing Patent Continuations* (working paper 2003) (discussing this use of continuations); Kimberly A. Moore, *Submarines and Patent Continuation Practice* (working paper 2003) (empirically establishing this practice).



issuance,<sup>99</sup> applicants are increasingly securing their ability to file additional claims through an extensive continuation practice. Although patentees who employ this tactic relinquish part of their patent term for the later-issued patents,<sup>100</sup> they can wait until competing products emerge and then attempt to obtain patent claims that will read directly on the competing product.<sup>101</sup> For the patentee, this eliminates concerns over claim construction and doctrine of equivalents issues that might otherwise challenge the patentee.<sup>102</sup> It creates concerns for society, however, since patent applicants may claim during prosecution to have invented something that was in fact first created by a competitor. Of late, the Federal Circuit has been increasingly preoccupied with ways to prevent abuse of patent continuations.<sup>103</sup> The strong relationship between continuations, families, and litigation suggests that these issues will continue to challenge the courts.

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<sup>99</sup> 35 U.S.C. §251.

<sup>100</sup> The patent term for applications first filed on or after June 8, 1995 is twenty years from the earliest filing date; hence claims to earlier priority via continuation applications reduce the patent term. *See* 35 U.S.C. § 154.

<sup>101</sup> *See, e.g., Kingsdown Med. Consultants v. Hollister Ltd.*, 863 F.2d 867 (Fed. Cir. 1988) (expressly permitting this practice).

<sup>102</sup> Claim construction has become a tricky business. Claims constructions rendered by the district courts have been reversed 33% of the time by the Federal Circuit. Kimberly A. Moore, *Are District Court Judges Equipped to Resolve Patent Cases?*, 15 HARV. J. L. & TECH. 1 (2002). Accordingly, having claims which unambiguously cover an accused infringer's product can avoid the uncertainty that exists in claim construction. Similarly, the doctrine of equivalents has recently been limited in circumstances where the patentee disclosed an aspect of her invention but did not claim it. *See R.E. Service v. Johnson & Johnston, Inc.*, 285 F.3d 1046 (Fed. Cir. 2002) (en banc). Those limits can be avoided by prosecuting a continuation application and using it to claim the omitted aspect. *Id.* at 1055.

<sup>103</sup> The court has created an entirely new doctrine – prosecution history laches – to deal with the problem. *Symbol Tech., Inc. v. Lemelson Med.*, 277 F.3d 1361 (Fed. Cir. 2002); *In re Bogese*, 303 F.3d 1362 (Fed. Cir. 2002). It has also rejuvenated another doctrine – written description – for this purpose. The Federal Circuit has also employed the written description requirement in this same effort. *See, e.g., Gentry Gallery, Inc. v. Berkline Corp.*, 134 F.3d 1473 (Fed. Cir. 1998); *Hyatt v. Boone*, 146 F.3d 1348 (Fed. Cir. 1998). *See generally* Lemley, *Abolishing*, *supra* note \_\_\_ (discussing these efforts); Moore, *Submarines*, *supra* note \_\_\_ (explaining the importance and impotence of the doctrine).

**b. Prosecution Length**

Litigated patents also spent significantly longer in prosecution than issued patents. The NBER data in the large population study gave us only the year of filing, so it provides only a coarse measure of the time spent in prosecution. Moreover, the NBER data count prosecution time only from the filing of the application leading most directly to a given patent and not from the original priority filing date in cases where the patent resulted from a chain of one or more ancestor applications. Nonetheless, the regression analysis in the large population study confirms that time in prosecution is significantly predictive of likely litigation.

To get more nuanced data, in the sample study we measured the number of days a patent spent in prosecution from the original priority filing date. The results demonstrate the magnitude of the difference between litigated and issued patents. Litigated patents spent 4.13 years in prosecution on average, compared with 2.77 years on average for non-litigated patents.<sup>104</sup>

Time in prosecution is of course strongly correlated with the number of continuation and CIP applications filed. The more times the patent applicant returns to the examiner to argue its case, the longer prosecution will take. Pendency times are also highly correlated with the number of claims and the number of total prior art references, as well as with the size of the patent family. For this reason, time in prosecution was not a significant predictor of litigation in the multivariate regression in the sample study once we controlled for these many interactions among variables.<sup>105</sup> It is notable, however, that if the total number of U.S. applications had been

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<sup>104</sup> This difference is statistically significant ( $p < .0001$ ).

<sup>105</sup> To confirm this result, we compared time in prosecution in each data set for those patents that were based on only one patent application, thus removing the effect of ancestors. For the 707 patents out of 1,000 (70.7%) in the general patent data set that were based on only one application, the average pendency time was 2.02 years. For the 138 patents out of 300 in the litigated patent data set that were based on only one application, the average pendency time was 2.14 years. Thus, the litigated patents spent longer in the PTO when counting those resulting from a single application, but using a t-test assuming equal variances, the difference was not significant. We then made the comparison in a slightly different way: In both data sets, we created a second column for years in the PTO from the

removed from the regression model, time spent in the PTO would have been a significant predictor of litigation in the sample study despite the presence of all the other interactions. Because the total number of U.S. applications and the size of the patent family signal much of the same information, the regression model arguably should have omitted total number of U.S. applications, in which case time spent in the PTO would have been a significant predictor of litigation.<sup>106</sup>

Litigation is more likely to occur when patents are young, as Figure 2 and Table 4 in the Appendix show.<sup>107</sup> The probability of litigation in any given year drops as patents age. This implies that if a patent is going to be litigated it will be litigated relatively early in its life. Given the connection between litigation and value, it follows that the potential value of a patent is known early in its life—it is rare for a patent to become valuable and litigated late in its life.

While claims, prior art references, and citations received are good measures of patent value and generality, originality and patent classifications are not, these measures do not tell the whole story. Our multiple regressions in both the large population and the sample study demonstrate that there are additional factors that are significant predictors of patent value. We have identified at least two new ones: related patents issuing from the same original application (patent families) and length of time in prosecution.

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most recent application. We found that, counting only from the most immediate application, litigated patents spent 2.07 years in the PTO and unlitigated patents spend 2.02 years in the PTO. Again using a t-Test assuming equal variances, the difference was not significant. Thus, the different pendency times for litigated and unlitigated patents was attributable to the filing of continuing applications. Curiously, Allison and Tiller find a significant difference between pendency times between Internet business method patents and the average patent. This difference is most striking when counting only from the most immediate application leading directly to the patent under study. *See Allison & Tiller, Business Method Patent Myth, supra note 616176, at* \_\_.[AUTHOR: Please provide pincite] [the article is not yet published, so how do I provide a pincite?]

<sup>106</sup> The exercise of judgment is always necessary in the building of a regression model.

<sup>107</sup> Age is measured as the number of years from grant of a patent to the end of the year in which the litigation ended: either 1999 or 2000.

Our results point the way toward a more accurate measure of valuable patents: a composite that takes into account a variety of different factors, including but not limited to the ones economists have traditionally measured. This composite measure of value, taken from our overall results, could significantly improve the measurement of patent value, turning it from a black art into something that more closely approximates a science.

## B. Patent Value Theory

One of the most striking things about the composite measure of patent value we developed in the previous section is that virtually all of the characteristics we have identified are either within the control of the applicant or at least known to it before or during patent prosecution. Patent applicants determine how many claims they will write and pay for, how many times they will abandon and refile their patent applications,<sup>108</sup> and how many related applications they will file. They have a substantial influence on both the time spent in prosecution<sup>109</sup> and the number and type of prior art citations made during prosecution.<sup>110</sup> And

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<sup>108</sup> An exception is divisional applications, which are responses to “restriction requirements” imposed by the PTO, 35 U.S.C. § 121. But they are a less significant part of patent continuation practice. See Allison & Lemley, *Who’s Patenting What*, *supra* note \_\_, at 2120 (15.9% of applications include at least one continuation, 11.1% include at least one CIP, but only 9.9% include at least one divisional).

<sup>109</sup> Prior empirical work by Mark Lemley finds that patents that spend a long time in prosecution often resulted from applications that were abandoned and refiled several times, suggesting that the applicant rather than the PTO was responsible for a significant part of the delay. See Mark A. Lemley, *An Empirical Study of the Twenty-Year Patent Term*, 22 AIPLA Q.J. 369, 391-92 (1994). And Allison and Lemley find that the number of applications filed is significantly related to the time spent in prosecution. Allison & Lemley, *Who’s Patenting What?*, *supra* note [Error! Bookmark not defined. Error! Bookmark not defined.](#), at 2140.

<sup>110</sup> Because the patent laws do not require an applicant to search for prior art before filing a patent application, an applicant can directly control how much prior art it submits to the PTO by deciding whether or not to conduct a search and, if so, how extensive that search will be. Further, there is strong circumstantial evidence that most prior art cited in U.S. patents is submitted by the applicant, not found independently by the examiner. See, e.g., Allison & Lemley, *Growing Complexity*, *supra* note [343449](#), at 133 & n.120 (noting that prior art citations tend to track the country of invention, which would not be true if the Examiner rather than the applicant was finding the art); Allison & Tiller, *Business Method Patent Myth*, *supra* note [616176](#), at [V.A.1] (noting that applications within an area of technology have a bimodal distribution of prior art citations, which is consistent with some applicants citing more art than others but is harder to square with the same examiners citing very different amounts of art).

they are aware of the area of technology, the national origin of the inventor, and the nature and size of the patent owner. Indeed, of the measures we have found predictive of patent litigation, only two – age of the patent when the lawsuit is filed and citations received – are unknown to the applicant by the time the patent issues.<sup>111</sup> Patent value, then, is not just something that academics can identify after the fact but something that patent owners themselves can predict in advance. Writing a patent with more claims, citing more prior art of all types, filing and prosecuting more applications, and spending more time in the PTO are all costly activities because they involve spending more in legal fees. The fact that some patentees voluntarily enter into a longer and more costly prosecution process suggests that they know or suspect going in that the patent will be valuable, and that the additional prosecution will be worth it.<sup>112</sup>

The fact that patent owners have strong reason to suspect which patents are valuable early in the process casts some doubt on the idea of patents as lottery tickets. Some have suggested that innovation and patenting are effectively lotteries, in which people with ideas gamble that

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<sup>111</sup> With respect to citations received, the patentee does exert some control, since it can control the number of self-citations that are made.

<sup>112</sup> Expanded prosecution is “worth it” to patentees only if it produces some benefit in litigation or licensing. The evidence is fairly strong that each of these components do in fact affect litigation outcomes. Each claim represents an attempt to define the invention in a way that is both valid and likely to be infringed, and more claims should give the patentee a better shot at prevailing in litigation against any particular accused device. Further, Allison and Lemley have found that factfinders are less likely to invalidate a patent on the basis of art already considered by the PTO, see Allison & Lemley, *Litigated Patents*, *supra* note [Error! Bookmark not defined.](#)[Error! Bookmark not defined.](#)<sup>28</sup>, at 234, so citing prior art to the PTO can help to “bulletproof” a patent. *Cf.* Jay P. Kesan, *Carrots and Sticks to Create a Better Patent System*, 17 BERKELEY TECH. L.J. 763 (2002) (arguing that applicants have an incentive to put lots of prior art before the PTO in order to be able to claim that it has been considered during subsequent litigation). The filing of continuation applications gives the patent applicant the opportunity to argue repeatedly for claims of a scope the examiner was initially unwilling to allow. *See, e.g.*, Merges, *supra* note [202034](#); Thomas, *supra* note [202034](#) (discussing flaws in the PTO examination process). And both the filing of multiple applications and extended time in prosecution give patentees a chance to see how their competitors design products and, if necessary and possible, change their claims to cover those products. *See, e.g.*, *Kingsdown Med. Consultants v. Hollister, Inc.*, 863 F.2d 867 (Fed. Cir. 1988) (patent applicants are free to change their claims during prosecution to track a competitor’s product). *But cf.* *Gentry Gallery, Inc. v. The Berklene Corp.*, 134 F.3d 1473 (Fed. Cir. 1998) (claim changed to track competitor’s product was invalid where the original specification did not support the claim).

their particular idea will catch on.<sup>113</sup> On this theory, patent applicants may simply be buying lottery tickets – spending some money now in the hopes that their patent will be one of the few that pays off a dozen or so years later.<sup>114</sup> There is something to this idea; certainly, no patent is a guarantee of success in the marketplace.<sup>115</sup> But if valuable patents can be reliably identified at the time of application, or at least at the time of issue, the lottery theory runs into difficulty. At best, it becomes only a partial explanation – patentees may identify some clearly valuable patents, and may also apply for other patents in the hopes they might pay off.

More important for purposes of patent policy than whether this expanded prosecution process is rational for patentees is whether it improves the quality of the outcome. Many of the factors that are strongly correlated with litigation also substantially affect the extent and quality of the patent prosecution process. One (optimistic) view of this relationship is the “patent value theory” offered by Allison and Lemley. They write:

On this theory, companies have started to pay greater attention to their patent portfolios, making greater use of the patents they have. Certainly there is anecdotal evidence that patents have a higher profile in companies now than they had in the 1970s. Also, patent litigation is increasing; it may be that licensing is increasing too. An increase in the importance of patents may in turn mean that patentees are willing to expend more effort to “get it right,” thereby increasing the post-issuance value of their patents. Filing more claims is one way to do that, as it makes it more likely that a patent will “read on” an accused infringer’s device. Citing more prior art will also make a patent more valuable in litigation, as it is

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<sup>113</sup> See Scherer, *supra* note [Error! Bookmark not defined.](#)<sup>14</sup>.

<sup>114</sup> Prior studies of patent litigation show that it takes over twelve years on average from the time a patent application is filed to the time litigation is completed. See John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 AIPLA Q.J. 185, 236 Table 11 (1998) (hereinafter *Litigated Patents*).

<sup>115</sup> See, e.g., HERBERT HOVENKAMP ET AL., IP AND ANTITRUST ch. 4 (2003 edition); HERBERT HOVENKAMP, ECONOMICS AND FEDERAL ANTITRUST LAW § 8.3, at 219 (1985) (“Many patents confer absolutely no market power on their owners . . . . The economic case for ‘presuming’ sufficient market power . . . is very weak.”); Nat’l Inst. on Indus. & Intellectual Prop., *The Value of Patents and Other Legally Protected Commercial Rights*, 53 ANTITRUST L.J. 535, 547 (1985) (“Statistical studies suggest that the vast majority of all patents confer very little monopoly power.”); William Montgomery, Note, *The Presumption of Economic Power for Patented and Copyrighted Products in Tying Arrangements*, 85 COLUM. L. REV. 1140, 1156 (1985) (“More often than not, however, a patent or copyright provides little, if any, market power.”).

much harder to prove a patent is invalid if the PTO has already considered and rejected the relevant prior art. More claims and more prior art may mean a longer prosecution process, particularly if the patentee is willing to fight harder to get patent claims with significant scope. Fighting for a broad patent may necessitate refiling, further delaying the issuance of a patent.<sup>116</sup>

If the patent value theory is correct, it suggests that the PTO is devoting its resources in the right place – disproportionately spending time examining the most valuable patents.

Our studies provide resounding support for the factual predicates of the patent value theory. It is clearly true that the patents with the most extensive prosecution records are also the most valuable patents. All may not be as rosy as the patent value theory would predict, however. The key question is whether a more extensive patent prosecution translates into a more rigorous evaluation of the application by the PTO. There are reasons to be skeptical. Patent examiners have notoriously heavy caseloads,<sup>117</sup> and they are rewarded only for an initial response to a patent application and for finally disposing of a case.<sup>118</sup> As a result, an examiner has no incentive to spend more time on harder cases; quite the contrary. There is reason to worry, therefore, that patents with multiple claims and lots of prior art will get less, not more, attention paid at the PTO to each claim or piece of prior art. An applicant's ability to file continuation applications and draw the process out even further exacerbates the problem. Because an

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<sup>116</sup> Allison & Lemley, *Growing Complexity*, *supra* note [343449](#), at 139.

<sup>117</sup> See, e.g., John R. Thomas, *The Question Concerning Patent Law and Pioneer Inventions*, 10 HIGH TECH. L.J. 35, 100 (1995) (referring to examiners as “notoriously overworked”); Simson Garfinkel, *Patently Absurd*, WIRED, July 1994, at 104; Eugene R. Quinn, Jr., *The Proliferation of Electronic Commerce Patents: Don't Blame the PTO*, 28 RUTGERS COMP. & TECH. L.J. 121, 122 (2002); Flavio Rose, *Patent Truths*, L.A. LAW., Oct. 2001, at 40.

<sup>118</sup> For a full discussion of the difficulties with the examiner incentive system, see Thomas, *Bounties*, *supra* note \_\_\_, at 324; 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); Arti K. Rai, *Addressing the Patent Gold Rush: The Role of Deference to PTO Patent Denials*, 2 WASH. U. J. L. & POL'Y 199, 218 (2000).

examiner can only finally dispose of an application by allowing it,<sup>119</sup> an examiner faced with a determined applicant has every incentive to give in and allow the patent.

The patent value theory has an important germ of truth, however. The PTO cannot be expected to devote enough resources to conduct rigorous examinations of the nearly 350,000 applications it receives every year.<sup>120</sup> Our study allows the PTO to focus its limited resources on the applications that are most important to society. To do this, the PTO needs to give examiners the power and incentive to conduct a more rigorous examination of the most complicated applications. One way to do this is to change the credit system so that examiners are rewarded for the work they actually do, rather than merely for the number of patents they allow. The Ninth Circuit Court of Appeals, recognizing that some cases are harder than others, rates the complexity of cases on a scale of 1 to 10 and assigns fewer cases to judges who must handle the most complex ones.<sup>121</sup>

The PTO can and should do something similar. While evaluating the patent to create a subjective rating would take new resources, the PTO could quite easily create an objective composite or algorithm based on the number of claims and prior art citations.<sup>122</sup> And it should use the resources that will shortly be available to it under the 21<sup>st</sup> Century Strategic Plan<sup>123</sup> to

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<sup>119</sup> See Thomas, *Bounties*, *supra* note \_\_, at \_\_; Lemley, *Abolishing*, *supra* note \_\_, at \_\_.

<sup>120</sup> See Lemley, *Rational Ignorance*, *supra* note 7 (making this argument). The U.S. PTO received 345,732 applications in 2001. [http://www.uspto.gov/web/offices/ac/ido/oeip/taf/us\\_stat.pdf](http://www.uspto.gov/web/offices/ac/ido/oeip/taf/us_stat.pdf).

<sup>121</sup> See Joseph N. Akrotirianakis et al., *Jerry-Building the Road to the Future: An Evaluation of the White Commission Report on Structural Alternatives for the Federal Courts of Appeals*, 36 *SAN DIEGO L. REV.* 355, 365 n.77 (1999).

<sup>122</sup> Both of these measures can change during prosecution, so the complexity weight given to a particular patent will not necessarily remain constant over time.

<sup>123</sup> <http://www.uspto.gov/web/offices/com/strat2001/index.htm>.



strengthen art units with a disproportionate number of valuable patent applications.<sup>124</sup> If the PTO focuses its resources on the patents that are most likely to matter in the real world, the promise of the patent value theory – that the patents that are most important also get the most scrutiny – can become a reality.<sup>125</sup>

### **III. Whose Patents Are Litigated**

The previous section focused on the characteristics of the patent itself. In this section, we move up one level of generality, looking at who is obtaining the patents in our studies. We tested several different characteristics of patent applicants: whether they are foreign or domestic; whether they are corporations, governments or individuals; how many inventors were named on the patent; and whether the applicant claimed “small entity” status as either an individual, a non-profit, or a small company. All of these factors differed significantly between litigated and unlitigated patents.

#### **A. Small Inventor Patents Are Litigated More**

One of the most striking findings of our study is the prevalence of patents issued to individual inventors and small businesses in litigation. Patents originally issued to by individuals and small businesses were far more likely to be litigated than patents originally issued to large

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<sup>124</sup> Recent empirical work by Cockburn, Kortum & Stern has found substantial variation by individual examiner in the quality of patent examination. Iain Cockburn, Samuel Kortum & Scott Stern, *Are All Patent Examiners Equal? The Impact of Examiners on Patent Characteristics and Litigation Outcomes*, (working paper 2002); see also Dennis Crouch & Douglas Lichtman, *Evaluating Patent Examiners: Evidence from Patent Prosecution*, 71 **U. Chi. L. Rev.** \_\_ (forthcoming January 2004) (same). This suggests that the PTO might try to concentrate important patents with better examiners, though Cockburn et al’s finding that examiner experience and workload don’t predict outcomes may make that hard to do in any systematic way.

<sup>125</sup> One possible worry is that skilled patent lawyers could manipulate such a system to get more or less examination. That is not necessarily a bad thing, however, if the presumption of validity accorded those patents in litigation is tailored to how much examination the PTO actually did.

corporations. Parallel work by Moore has found that a large percentage of the patents that are litigated have changed hands since the patent issued.<sup>126</sup> It is the new purchaser, not the inventor or even the original assignee, who tends to file suit. Patents that issued to the inventor him or herself (“unassigned” patents) and patents assigned to another U.S. individual<sup>127</sup> collectively account for 18% of total patents, but 27% of litigated patents in the large population study.<sup>128</sup> The remainder of patents are assigned to corporations or governments.

This data is confirmed by our analysis of small inventor status in the sample study.<sup>129</sup> The PTO identifies individual inventors, small businesses,<sup>130</sup> and non-profit organizations as small entities. These entities collectively accounted for 482 of the 1300 patents in the sample study. The litigation differences are striking. 39.2% of the patents in the litigated sample were initially issued to small entities,, whereas only 13.6% of the patents in the litigated sample

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<sup>126</sup> Kimberly Moore, *Can David Compete With Goliath in Our Patent Model?* (working paper 2003).

<sup>127</sup> A very small number of patents were assigned to foreign individuals. Those patents are actually somewhat less likely than unassigned patents to be litigated, but the difference is not statistically significant.

<sup>128</sup> The sample study contains similar results. 23.1% of the patents in the sample study were litigated. When broken down by individual owner versus corporate owner, the data show that 38.8% of individually owned patents in the sample study were litigated, compared with 18.6% of those owned by corporations. Similarly, 33.2% of unassigned patents were litigated, compared with only 21% of assigned patents. Both results are statistically significant (p values <.0001 in both cases).

We should pause here to ensure that the way in which we have measured data in the sample study does not confuse. The sample study contains 1,000 unlitigated patents and 300 litigated ones, both numbers randomly selected from a larger pool for purposes of study. Thus, it happens that 23.1% of the patents in our sample were litigated. This is an artifact of the numbers of patents we chose to examine. It does *not* mean that 23.1% of patents in the general population are litigated. The actual percentage of patents that are litigated is far less – around 1.5%. See Lemley, *Rational Ignorance*, *supra* note 7, at 1501. The way to understand the data from the sample study, therefore, is to compare the percentages to the baseline in the sample (23.1%), not to assume that, e.g., 38.8% of all patents owned by individuals in the general population will end up being litigated.

<sup>129</sup> Small entity status must be coded by hand in the PTO, and is not available for the large population of patents. Further, small inventor status became relevant only in 1983, when the law changed to require the PTO to charge lower fees to small entities, so it cannot fairly be evaluated in a population that dates back to 1963. We are grateful to Jim Hirabayashi of the PTO for providing us with small entity data for the patents in the sample study.

<sup>130</sup> An entity is defined by the PTO as “small” if it meets the requirements of 35 U.S.C. §41(h)(1), which incorporates by reference section 3 of the Small Business Act. A small entity is either an individual, nonprofit, or a corporation with fewer than 500 employees.

were initially issued to large entities.<sup>131</sup> The magnitude of this effect is best captured by looking only at the litigated patents in the sample study. While 71% of the patents in the non-litigated sample were initially issued to large corporations only 37% of the litigated patents in the sample were initially issued to such firms.

## **B. Explanations and Implications**

There are several possible explanations for these results. But whatever the explanation, it is clear that the classical model of the patent system, in which inventors sell products based on their invention and use their patents to exclude competitors from the market, is not an accurate description of the way patents work in the real world.<sup>132</sup> What might account for the remarkable prevalence of patents obtained by individuals and small companies in the litigation data? In this section, we consider two possible explanations.

### **1. The Genius of the Small Inventor**

The first possible interpretation of our findings is that small rather than large entities are the real wellsprings of innovation in the United States. The patent system has long conceived of invention as an activity conducted by lone geniuses, a model that had much more resonance in a

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<sup>131</sup> Breaking down the definition of small entities into its component parts reveals that both patents owned by individuals and those owned by small businesses were substantially more likely to be litigated than those owned by large businesses. 38.8% of individual-owned patents were litigated in our sample, compared with 18.6% of entity owned patents. Similarly, 41.2% of small business-owned patents were litigated in our sample, compared with 20.1% of other patents. Non-profits, on the other hand, were not significantly more or less likely to litigate than other types of entities. All of the results reported in this paragraph show a statistically significant difference ( $p < .0001$ ) except the results for non-profit entities.

<sup>132</sup> The fact that patents unassigned at issue are more likely to be litigated also casts some doubt on Barney's new model of patent value, since his model predicts that unassigned patents tend to be at the low end of the value scale. See Barney, *supra* note ~~151520~~, at 351-52 & Tables 4-5.

world of 19<sup>th</sup>-century mechanical inventions than in today's "big science."<sup>133</sup> While the patent system still favors small inventors in various ways,<sup>134</sup> prior empirical work has found that large companies obtain the overwhelming majority of patents today and suggested that the days of the individual inventor are numbered.<sup>135</sup> But if the decreasing percentage of patents that issue to small inventors are in fact the most valuable patents, that conclusion is suspect. On this interpretation, small inventors working in garages, not large corporate research departments, are responsible for critical breakthroughs in many areas of science.<sup>136</sup>

If this interpretation is correct, patent law arguably should be doing more than it is to facilitate patenting by small inventors. The small inventor lobby has resisted recent changes to

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<sup>133</sup> For a discussion of the lone inventor and his iconic status in patent law, see, e.g., Catherine L. Fisk, *Removing the Fuel of Interest from the Fire of Genius: Law and the Employee-Inventor, 1830-1930*, 65 U. CHI. L. REV. 1127 (1998); Mark D. Janis, *Patent Abolitionism*, 17 BERKELEY TECH. L.J. 899, 910 (2002).

<sup>134</sup> Among other things, U.S. patents can issue only to individuals, though those individuals can assign their patents to a company, 35 U.S.C. §§ 116, 118; individuals and small businesses pay only half the fees a large business does to obtain a patent, 35 U.S.C. § 41(h)(1); individual inventors are given more favorable treatment than corporations with respect to excuses for delay in reducing an invention to practice. See *Griffith v. Kanamaru*, 816 F.2d 624 (Fed. Cir. 1987); and the small inventor lobby has proven quite capable of derailing or substantially altering legislation that it perceives as favoring large companies over individual inventors. See Mark A. Lemley & Colleen Chien, *Are the U.S. Patent Priority Rules Really Necessary?*, 54 HASTINGS L.J. \_\_\_ [AUTHOR: Please provide complete source and citation info](forthcoming 2003) (discussing various provisions of the American Inventors' Protection Act that were designed to placate the small inventor lobby).

<sup>135</sup> See Allison & Lemley, *Who's Patenting What*, *supra* note [Error! Bookmark not defined.](#)<sup>17</sup>, at 2116-17 (over 70% of patents were issued to large entities during mid-1996 to mid-1998); Allison & Lemley, *Growing Complexity*, *supra* note 46, at 97 (percentage of patents issued to corporations rather than to individuals increased significantly from the 1976-78 period to the 1996-98 period). On the rise of corporate ownership of intellectual property, see, e.g., Catherine L. Fisk, *Working Knowledge: Trade Secrets, Restrictive Covenants in Employment, and the Rise of Corporate Intellectual Property, 1800-1920*, 52 HASTINGS L.J. 441 (2001).

<sup>136</sup> There is a good deal of anecdotal evidence to support the idea that truly innovative ideas come from upstarts rather than established players. See, e.g., ANDREW S. GROVE, *ONLY THE PARANOID SURVIVE* (1996). Much of this evidence is concentrated in the software and Internet industries, where barriers to entry have traditionally been low and where many innovators (Hewlett and Packard, Jobs and Wozniak, Page and Brin) worked outside an established corporate framework.

There is also some limited empirical evidence suggesting that dramatic changes may come from small rather than large companies. See Hearings on H.R. 359, H.R. 632, H.R. 1732, and H.R. 1733 Before the Subcomm. on Courts and Intellectual Property of the Comm. on the Judiciary House of Representatives, 104th Cong. 137-39 (1995) at 368-90 (statement of David L. Hill, President of the Patent Enforcement Fund, Inc.). (citing a Department of Commerce Study from the 1960s suggesting that the most important inventions were made by independent inventors, even though companies spend more on research and development).

the patent law designed to harmonize U.S. patent rules with those in the rest of the world.<sup>137</sup> To the extent those changes would actually disadvantage small inventors – a highly debatable proposition<sup>138</sup> -- Congress should make sure it doesn't stifle the most important kinds of innovation in an effort to make rules that benefit the large number of owners of more routine inventions.<sup>139</sup>

## 2. Asymmetric Stakes

A second explanation for the prevalence of small entities in litigation is rather more pessimistic than the first. It may be that individuals and small entities are more likely than large companies to sue because they have little to lose from entering into patent litigation.<sup>140</sup> Large companies in many industries hold patents for defensive purposes, precisely in order to deter

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<sup>137</sup> See Janis, *supra* note [133133153](#), at 918-19 (changes in the AIPA “bear the unmistakable influence of lobbying on behalf of independent inventors.”).

<sup>138</sup> Recent empirical evidence has shown that small inventors do not in fact benefit from the U.S.’s unique first-to-invent system, for example. See Gerald J. Mossinghoff, *The U.S. First-to-Invent System has Provided No Advantage to Small Entities*, 88 J. PAT. & TRADEMARK OFC. SOC’Y 425 (2002); Lemley & Chien, *supra* note [134134154](#), at \_\_\_[AUTHOR: Please provide pincite].

<sup>139</sup> For example, the fact that litigated patents spend much longer in prosecution than other patents, *see supra* note \_\_\_ [Part II.A.2.b] and accompanying text, suggests that the change from a 17-year-from issue patent term to a term that ends 20 years from the filing date may disadvantage owners of the most valuable patents. Cf. Lemley, *20-Year Patent Term*, *supra* note [109109128](#), at 421 (noting that litigated patents receive less protection under the 20-year term than average patents). Of course, there are other explanations for this change. To the extent that patents spend more time in prosecution because the applicant files multiple continuation applications, *see id.* at 391-92 (finding this), they may reasonably be thought to have brought the problem on themselves. Moreover, the relatively small reduction in the term of protection is unlikely to reduce the value of patents because very few confer significant market power, and even in the case of those that do, the passage of time allows for the introduction of more competing alternatives so that the last portion of the patent term probably isn’t worth very much. Pharmaceutical patents are the main exception to this proposition, because they tend to be most valuable at the end of the patent term, when the drug has finally been approved by the FDA.

<sup>140</sup> Lanjouw & Schankerman put it differently – that corporate patentees in a symmetrical relationship have “advantages in settlement.” Lanjouw & Schankerman, *Characteristics*, *supra* note [363651](#), at 130.

other large companies from suing them.<sup>141</sup> The result is a sort of “mutually assured destruction” in which very few companies actually sue for patent infringement because they know that if they do, their opponents will also be able to sue them for patent infringement. Rather, if there are any patent disputes at all between these companies they tend to end in royalty-free cross-licenses.<sup>142</sup>

Small entities often lack this symmetry between the costs and benefits of patent enforcement. In particular, the plaintiffs with the least to lose from litigation are those who do not themselves participate in the development or sale of products, but instead simply seek payment from others who actually make the products. These non-manufacturing plaintiffs or “licensing shops” need not fear that defendants will assert patents against them.<sup>143</sup> Thus, there is no downside other than the cost of legal fees to enforcing their patents. There is anecdotal evidence that in certain industries, particularly semiconductors, most patent lawsuits are filed by a small number of individuals or companies with asymmetric stakes.<sup>144</sup>

If the asymmetric stakes interpretation is correct, it suggests that courts and scholars must rethink the traditional understanding of patents as a means for inventors to exclude competitors. Patents owned by large entities instead look more like a socially wasteful expenditure made

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<sup>141</sup> See, e.g., Hall & Ziedonis, *supra* note 12; Lemley, *Rational Ignorance*, *supra* note 7, at 1504-05; Mark A. Lemley, *Reconceiving Patents in the Age of Venture Capital*, 4 J. SMALL & EMERGING BUS. L. 137, 143 (2000) (“One of the major reasons that companies get patents is that they’re afraid that their competitors have them, and they don’t want to be the only one left who doesn’t have the ability to play in this game.”); John H. Barton, *Reforming the Patent System*, 287 SCIENCE 1933 (2000) (discussing this defensive patenting practice).

<sup>142</sup> See, e.g., Lanjouw & Schankerman, *Enforcement*, *supra* note ~~363651~~, at 4 (“Patentees with a large portfolio of patents to trade . . . more successfully avoid court actions.”); Lemley, *Rational Ignorance*, *supra* note 7, at 1505.

<sup>143</sup> On the policy problems associated with litigation by licensing shops, see Michael J. Meurer, *Controlling Opportunistic and Anti-Competitive Intellectual Property Litigation*, 43 B.C. L. REV. \_\_\_, [draft at 8, 11-12] (forthcoming 2003) [AUTHOR: Please provide complete source and citation info], at 11-12; Julie S. Turner, *The Nonmanufacturing Patent Owner: Toward a Theory of Efficient Infringement*, 86 CALIF. L. REV. 179 (1998).

<sup>144</sup> In the semiconductor industry, for example, three of the most frequent patent plaintiffs are Jerome Lemelson, Rambus, and Texas Instruments. Lemelson and Rambus don’t make products, choosing merely to license intellectual property instead. While TI does make products, it litigated primarily in the area of large-scale integrated circuits, a field in which it did not have significant sales by the time of the lawsuits. See Lemley, *Rational Ignorance*, *supra* note 7, at 1505 & n.44.

necessary only by the fact that other large entities also own patents. And patents owned by licensing shops arguably operate mainly as transaction costs, obstacles that their owner can put in the way of those developing innovative products in order to extort some of the value of those products.<sup>145</sup> This doesn't mean that patents have no social value. They may be useful vehicles for technology transfer, permitting non-manufacturing inventors to sell their ideas to those with the resources to implement those ideas. But a patent right based on technology transfer by non-manufacturing plaintiffs would look very different from our current system. There would be little reason to hold liable defendants who had independently developed the patented invention, as patent law currently does.<sup>146</sup> Independent invention would negate any social benefit from technology transfer. And there would be no reason to grant injunctive relief rather than licensing revenue to non-manufacturing plaintiffs, since they cannot be trying to maintain market exclusivity.<sup>147</sup>

### 3. Implications

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<sup>145</sup> See Meurer, *supra* note ~~143~~<sup>143</sup> (arguing that opportunistic patent lawsuits are increasing).

<sup>146</sup> A number of scholars have recently proposed creating an independent invention defense in patent law or otherwise penalizing nonmanufacturing patent owners. See, e.g., Stephen M. Maurer & Suzanne Scotchmer, *The Independent-Invention Defense in Intellectual Property*, 69 *ECONOMICA* 535 (2002); Michelle Armond, Comment, *Introducing the Defense of Independent Invention to Patent Preliminary Injunctions*, 91 *CALIF. L. REV.* 117 (2003); John S. Liebowitz, *Inventing a Nonexclusive Patent System*, 111 *YALE L.J.* 2251 (2002); Julie S. Turner, *The Nonmanufacturing Patent Owner: Toward a Theory of Efficient Infringement*, 86 *CALIF. L. REV.* 179 (1998).

<sup>147</sup> A few courts have exercised discretion not to grant injunctive relief to a non-manufacturing patentee. *Foster v. Am. Mach. & Foundry Co.*, 492 F.2d 1317, 1324 (2d Cir. 1974); *Smithkline Beecham Corp. v. Apotex Corp.* 247 F. Supp. 2d 1011 (N.D. Ill. 2003). But the general rule is that patent infringement is enjoined. Nonmanufacturing patentees are penalized in the award of monetary damages, however; they can receive only a reasonable royalty rather than proving lost profits. See, e.g., *Panduit Corp. v. Stahl Bros. Fibre Works*, 575 F.2d 1152, 1158 n.5 (6<sup>th</sup> Cir. 1978) (setting out the standard test for proof of lost profits, which requires a showing that the patentee would have made the infringer's sales).

Each of the explanations for the prevalence of small entities in litigation is plausible. Further, they are not mutually exclusive; it may well be that each is true in part. Whatever the true explanation, one thing is clear: our traditional understanding of patent litigation will have to change. Prior scholars have pointed to the paucity of patent litigation to challenge the theory of patents as grants of market exclusivity.<sup>148</sup> Our research extends that challenge, making it clear that even in the unusual case in which a patentee files suit, the goal of the suit is not necessarily exclusivity against competitors.

### C. Other Findings

Our other findings in this area either confirm well-established results or do not seem to have that much significance. We found that patents issued to foreign owners are much less likely to be litigated than patents issued to U.S. owners. Foreign-owned patents accounted for 46% of issued patents, but only 17% of litigated patents. This is consistent with prior work we have done suggesting that foreign patentees are much less likely to use their patents in court.<sup>149</sup> We also found that litigated patents have fewer inventors than unlitigated patents, though the difference is relatively modest. Issued patents have a mean of 2.1 inventors, while litigated patents have a mean of 1.9 inventors. This difference in the large population study is statistically significant even when we control for the number of patents owned by individuals (who often work alone) versus corporations. Nor is it an artifact of the fact demonstrated in our sample study that patents originally issued to small entities are more likely to be litigated than those

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<sup>148</sup> See Lemley, *Rational Ignorance*, *supra* note 7, at 1503-08; Long, *supra* note 11.

<sup>149</sup> See Moore, *Xenophobia*, *supra* note 12 (finding this empirically and offering a number of reasons foreign patent owners might be reluctant to litigate); Allison & Lemley, *Litigated Patents*, *supra* note [Error! Bookmark not defined. Error! Bookmark not defined.](#), 28, at 224-27.



originally issued to large companies. One possible explanation might be that work done by large teams of inventors tends to be more incremental, and therefore less valuable on average, than work done alone or in smaller groups.

#### IV.. What Industries Litigate Patents

Prior scholarship has demonstrated that different industries perceive patents very differently, rely on patents to different extents, and experience patent prosecution differently.<sup>150</sup> Industry-specific studies have come to very different conclusions about the role of patents in particular fields.<sup>151</sup> Our data reveal substantial differences in patent litigation patterns by industry.<sup>152</sup> The data show strong support for the general hypothesis that the patent system varies in its effects by industry, though they also raise questions about how predictable that variation is.

Patents in some industries are much more likely to be litigated than those in other industries. We identify some crude differences in the large population study, based on the rough

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<sup>150</sup> See, e.g., Richard C. Levin et al, *Appropriating the Returns from Industrial Research and Development*, 1987 BROOKINGS PAPERS ON ECON. ACTIVITY 783, 785-86 (finding differences across industries in patents granted per dollar of research and development expenditure); Wesley M. Cohen et al, *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)*, NBER working paper W7552 (Feb. 2000)(finding differences across industries in the use of patents relative to other methods of protecting intellectual property); Allison & Lemley, *Who's Patenting What*, *supra* note [Error! Bookmark not defined.](#)~~Error! Bookmark not defined.~~<sup>17</sup>, at 2146 (showing substantial variation by industry in the nature and importance of patents); see also Edwin Mansfield, *Patents and Innovation: An Empirical Study*, 32 MGMT. SCI. 173, 176 (1986) (examining the extent to which various firms and industries rely on the patent system to protect their innovations); Mark Schankerman, *How Valuable is Patent Protection? Estimates By Technology Field*, 29 RAND J. OF ECON. 77 (1998) (finding that the private value of patent rights in France differed by technology field).

<sup>151</sup> See, e.g., Hall & Ziedonis, *supra* note 12 (noting the primarily defensive use of patents in the semiconductor industry); see Nancy S. Dorfman, INNOVATION AND MARKET STRUCTURE: LESSONS FROM THE COMPUTER AND SEMICONDUCTOR INDUSTRIES 235-39 (1987) (discussing the importance of lead-time in the computer and semiconductor industries); Ashish Arora et al., *R&D and the Patent Premium* 1, 33 Tbl. 4 (working paper 2002) (demonstrating that patents give greater returns in some industries than others).

<sup>152</sup> It thus provides support for Dan Burk and Mark Lemley, who have argued that patent litigation differs by industry. Burk & Lemley, *supra* note \_\_; see also Dan L. Burk & Mark A. Lemley, *Is Patent Law Technology-Specific?*, 17 **Berkeley Tech. L.J.** 1155 (2002).

divisions of the NBER database into six industry categories: Mechanical, Computer and Communications, Electrical and Electronic, Drugs and Medicine, Other Chemistry, and Miscellaneous Other inventions.<sup>153</sup> The data are set forth in Table 2.

**Table 2**  
**Likelihood of Litigation by NBER Industry Category**

<u>Category</u>	<u>Issued Patents (weighted)</u>	<u>Litigated Patents</u>
Comp. and Comm.	13%	20%
Elec. and Electronic	18%	12%
Mechanical	21%	16%
Drugs & Med.	10%	16%
Chemistry	19%	10%
Other	20%	26%

The differences are significant. Drugs and medicine and computer and communications patents are far more likely to be litigated than their numbers in the general population would suggest. By contrast, mechanical, chemistry, and electrical and electronic patents are significantly underrepresented in the category of valuable litigated patents. These differences are statistically significant in the large population study.

The NBER categories are rather crude, and do not break out industries with unique characteristics like software, biotechnology, and semiconductors. They are also based on governmental patent classification systems that Allison and Lemley have shown are notoriously unreliable for identifying technology areas at a conceptual level.<sup>154</sup> The main reason is that, because they are designed to assist in narrowly tailored prior art searches, the government's classifications focus on the functional rather than the conceptual and do so at very low levels of

<sup>153</sup> See Hall, Jaffe & Trajtenberg, *NBER*, *supra* note \_\_\_, at \_\_\_.

<sup>154</sup> See Allison & Lemley, *Who's Patenting What*, *supra* note [Error! Bookmark not defined.](#)<sup>17</sup>, at 2114.

abstraction.<sup>155</sup> To get a better measure of how litigation patterns differed by industry, we hand-coded the patents in the sample study into fourteen different technology categories. Those categories are: pharmaceuticals, medical devices, biotechnology, computer-related, software, semiconductors, electronics, chemistry, mechanics, acoustics, optics, automotive-related, energy-related, and communications-related.<sup>156</sup> The results are presented in Table 3.

**Table 3**

Sample Study Litigation Probabilities by Area of Technology

Comparison Variable (Characteristic)	Percent litigated without characteristic	Percent litigated WITH characteristic	Difference in Proportions	Z	Statistic P Value
Pharm	23.6%	16.8%	6.7%		.1341
MedDev	21.6%	39.8%	18.2%		.0000
BioTech	23.1%	21.3%	1.9%		.7654
Comp_Rel	21.0%	29.7%	8.7%		.0016
Software	21.9%	33.3%	11.5%		.0025
SemiCond	24.3%	8.2%	16.1%		.0003
Electronics	20.7%	35.4%	14.7%		.0000
Chemistry	24.5%	17.5%	7.0%		.0157
Mechanics	17.1%	31.5%	14.4%		.0000
Acoustics	22.9%	30.0%	7.1%		.3625
Optics	22.6%	26.1%	3.5%		.2956
AutoRel	23.7%	14.1%	9.6%		.0426
EnergyRel	23.1%	23.3%	0.3%		.9731
CommunRel	22.7%	31.6%	8.9%		.1192

These results also show striking variation by industry. Patents on medical devices, computer-related inventions, software, electronics, and mechanics are significantly more likely to be litigated than the average of all patents. By contrast, chemistry, automotive, and semiconductor patents are significantly less likely to be litigated. The difference is most striking for

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<sup>155</sup> *Id.*

<sup>156</sup> The categories are non-exclusive. Patents in this random sample of 1,000 patents average 1.59 technology areas per patent. For a full description of each category, see *id.* at 2110-12.

semiconductors, where only 8.2% of the patents in the sample study were litigated, compared with 24.3% of the non-semiconductor patents. For software and computer-related patents at least, the large number of lawsuits is a recent development. Prior work based on cases terminated between 1989 and 1996 found that only a small percentage of those cases involved software patents.<sup>157</sup>

While both the large population and the sample studies show significant variation in litigation patterns by industry, the results of the sample study differ in some ways from the results in the large population study. Some of these differences result from the different and more precise definitions of technology areas in the sample study. For example, the “mechanical” category in the NBER data is really a sort of catchall “other” category, while the mechanical category in our sample study is more strictly limited to inventions that operate on mechanical principles. While NBER “mechanical” patents are less likely than average to be litigated, true mechanical patents are more likely to be litigated. Similarly, the “drugs and medical” category in the NBER data conflates three different types of invention: pharmaceuticals, biotechnology, and medical devices. When those categories are separated, as in our study, it is evident that only medical devices are significantly more likely than average to be litigated. Both pharmaceuticals and biotechnology inventions were actually somewhat less likely to be litigated in the sample, though the results were not statistically significant.

The fact that patents in some industries are much more likely to be valuable than those in other industries has significant implications both for study of the patent system and for patent policy. The clearest example of an industry-specific litigation result in our data concerns semiconductors. While semiconductor patents constitute a substantial fraction of all patents

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<sup>157</sup> See Allison & Lemley, *Litigated Patents*, *supra* note [Error! Bookmark not defined. Error! Bookmark not defined, 28](#), at 217 Table 5 (only 1% of litigated patents involved software inventions).

issued,<sup>158</sup> they are far less likely to be litigated than any other type of patent. Only 8.2% of the semiconductor patents in our small sample study were litigated, compared with 24.3% of the non-semiconductor patents in that sample.<sup>159</sup> The paucity of litigation in the semiconductor industry is consistent with sector-specific studies of that industry by Hall and Ziedonis and others,<sup>160</sup> and makes perfect sense given the pattern of mutually assured destruction that prevails among established companies in the industry.<sup>161</sup>

More surprising in light of industry-specific patent theories were the results in the pharmaceutical industry. Pharmaceutical patents were actually somewhat less likely than average to be litigated in our sample,<sup>162</sup> though the difference was not statistically significant.<sup>163</sup> This result seems quite surprising, given the large amounts of money at stake in pharmaceutical patent suits,<sup>164</sup> the large amount of research and development costs that go into the inventions,<sup>165</sup> the extensive lobbying efforts by pharmaceutical manufacturers for technology specific patent

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<sup>158</sup> In the period we studied, semiconductor patents accounted for 9.3% of total patents. See Allison & Lemley, *Who's Patenting What*, *supra* note [Error! Bookmark not defined. Error! Bookmark not defined.17](#), at Table 1.

<sup>159</sup> This difference was statistically significant (p=.0003).

<sup>160</sup> See Hall & Ziedonis, *supra* note [Error! Bookmark not defined. Error! Bookmark not defined.18](#).

<sup>161</sup> See *supra* notes \_\_\_-\_\_\_ [Part III.B.2] and accompanying text (describing this pattern)

<sup>162</sup> 16.8% of pharmaceutical patents in the sample were litigated, compared with 23.6% of non-pharmaceutical patents.

<sup>163</sup> p=.1341.

<sup>164</sup> To take just one example, Eli Lilly's stock fell almost 30% (and over \$34 billion) on the day its Prozac patent was held invalid, even though that occurred only one year before the patent would otherwise have expired. See <http://www.hewm.com/use/articles/elilly.pdf>.

<sup>165</sup> Estimates of the average cost of drug development and testing range from \$110 million to \$500 million; the latter is the industry's figure. Compare <http://www.phrma.org/publications/publications/profile01/chapter2.pdf> with <http://www.citizen.org/Press/pr-drugs33.htm>.

laws,<sup>166</sup> recent evidence that pharmaceutical companies have violated the antitrust laws in an effort to extend their patent rights,<sup>167</sup> and prior survey work that has found that pharmaceutical companies consider patents more important than companies in any other industry.<sup>168</sup> So too with biotechnology: biotechnology patents, which were no more likely to be litigated than other types of patents in the sample study.<sup>169</sup> This finding seems to contradict Josh Lerner's earlier prediction that biotechnology patent cases were significantly more likely to be litigated than other types of patents.<sup>170</sup> The data for biotechnology and pharmaceuticals are likely to be skewed by the nature of our sample study, however. Because we compared patents issued between 1996 and 1998 and litigated in 1999 and 2000, the sample study is naturally weighted towards patent litigation that occurs early in the life of a patent. This isn't necessarily a major limitation as a general matter – data from the large population study show that most litigated patents go to court when they are relatively young.<sup>171</sup> But it may undermine the robustness of the data for biotechnology and pharmaceuticals. Patents in these industries are most valuable at the end of their life, and won't be litigated until after FDA approval, something which can take

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<sup>166</sup> See, e.g., 35 U.S.C. §§ 155A, 156 (special term extensions for pharmaceutical patents); Robert Patrick Merges & Glenn Harlan Reynolds, *The Proper Scope of the Copyright and Patent Power*, 37 **Harv. J. Legis.** 45 (2000) (discussing efforts to extend patent terms); Robert P. Merges, *One Hundred Years of Solicitude: Intellectual Property Law, 1900-2000*, 88 **Calif. L. Rev.** 2187, 2234 n.217 (2000) (discussing example of proposed extension for Claritin patent).

<sup>167</sup> See, e.g., 2 HERBERT HOVENKAMP ET AL., *IP AND ANTITRUST* §33.9 (2003 edition); Herbert Hovenkamp et al., *Anticompetitive Settlement of Intellectual Property Disputes*, 87 **Minn. L. Rev.** 1719 (2003).

<sup>168</sup> See Levin et al, *supra* note [150150188](#); Wesley Cohen et al, *supra* note \_\_\_.

<sup>169</sup> In fact, only 21.3% of biotechnology patents in the sample were litigated, compared with 23.1% of non-biotechnology patents. But the difference was not statistically significant (p=.7654).

<sup>170</sup> See Josh Lerner, *Patenting in the Shadow of Competitors*, 38 **J. L. & ECON.** 463 (1995).

<sup>171</sup> See *infra* Figure 1.

decades.<sup>172</sup> Thus, the low numbers aren't necessarily representative of the ultimate litigation patterns in these industries.

Another somewhat surprising result is the large number of software and computer-related patent lawsuits. Patents in these categories were significantly more likely to be litigated than other kinds of patents.<sup>173</sup> This represents a significant change from a decade before, when software patent lawsuits were quite rare.<sup>174</sup> One possible explanation for the increase in software litigation could be the uncertainty in the legal standards and their application to software, which may have led to breakdowns in licensing negotiations and thus to litigation.<sup>175</sup> Scholars investigating the effect of the patent system on particular industries should take this data into account in exploring how the patent system works in different industries.

Regardless of the specific litigation patterns in any given industry, our data clearly demonstrate that patents in some industries are far more likely to be valuable than patents in other industries. This data may suggest to some that industry specific patent laws or patent

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<sup>172</sup> Pharma estimates that the total time spent from the beginning of a research project to the marketing of a successful drug is 14.2 years, 1.8 years of which is due to the FDA approval process. See <http://www.phrma.org/publications/publications/profile01/chapter2.pdf>.

<sup>173</sup>  $p=.0025$  for software and  $p=.0016$  for computer-related inventions.

<sup>174</sup> See Allison & Lemley, *Litigated Patents*, *supra* note \_\_, at 217 Table 5 (only 1% of patents litigated to judgment between 1989 and 1996 were software patents).

<sup>175</sup> When there is substantial uncertainty in the law or its application it is more likely that the parties will disagree over their expected outcome, which will impede settlement. Cf. George L. Priest & Benjamin Klein, *The Selection of Disputes for Litigation*, 13 J. LEGAL STUD. 1 (1984) (explaining the divergent expectation model of case selection theory).

Software and the related business method patent applications (which often involve software) have risen dramatically in recent years. See Allison & Tiller, *Business Method Patent Myth*, *supra* note30. In fact, the patentability of these inventions was suspect until recently. Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CALIF. L. REV. 1 (2001). Commentators have challenged the likely validity of software patents that issue on the grounds that the patent office examination of these applications is weak due to a lack of searchable prior art and technical expertise. See Julie Cohen, *Reverse Engineering*, *supra* note \_\_. Changes in the technology, legal standards, and their application – which creates greater uncertainty in this area could be behind the increase in software litigation. If this prediction is accurate, we should see a decrease in software litigation once the application of the legal standards becomes more certain. Only time will tell.

prosecution procedures should replace the unitary patent system we have today.<sup>176</sup> While we don't necessarily endorse industry-specific legislation, those who design patent policy need to find ways to take the very real differences between industries into account without creating incentives for rent-seeking in Congress or the PTO.<sup>177</sup>

### Conclusion

Litigated patents differ significantly from other kinds of patents. These differences permit us to develop a composite picture of valuable patents, the ones lawyers, scholars and policy-makers will have to be most concerned with. This picture is important in its own right, because it provides important evidence on how to value patents and increases our understanding of the patent system. Our specific results are perhaps even more important, because they depict a patent prosecution system that may not give the optimal attention to the most important patent applications and a patent litigation system that bears little resemblance to the simple market-exclusivity story of traditional patent theory. Patent law will have to confront the realities that patents in some industries are more valuable than others, that the most valuable patents are also the most complex and the ones that take the longest to prosecute, and that the large companies

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<sup>176</sup> Among the many calls for industry specific patent legislation, see Matthew G. Wells, *Internet Business Method Patent Policy*, 87 VA. L. REV. 729, 770-72 (2001); Peter S. Menell, *Tailoring Legal Protection for Computer Software*, 39 STAN. L. REV. 1329 (1987); S. Benjamin Pleune, *Trouble With the Guidelines: On Urging the PTO to Properly Evolve With Novel Technologies*, 2001 J. L., TECH. & POL'Y 365; Pamela Samuelson, *Benson Revisited: The Case Against Patent Protection for Algorithms and Other Computer Program-Related Inventions*, 39 EMORY L.J. 1025 (1990). However, in the context of a large empirical study of Internet business method patents, John Allison and Emerson Tiller argue that using ex ante definitions of particular technology areas to single them out for specifically stricter or more lenient treatment in prosecution is both fruitless and ultimately counterproductive. They view it as fruitless because experienced patent attorneys have demonstrated their ability to draft patents in such a way as to opt into or out of such definitions, and counterproductive because of the increased transaction costs associated with tortuous drafting. Attorneys did so during the years when the status of software as patentable subject matter was questionable, and now do it to avoid a second-level of scrutiny in the PTO for certain business method patents. Allison & Tiller, *Business Method Patent Myth*, *supra* note 30, at -. They do not dispute the fact, however, that use of the "person having ordinary skill in the art" standard for determining questions such as adequacy of disclosure in the patent and obviousness will necessarily result in certain practical differences in determining the validity of patents in different fields. This is an entirely different matter than singling them out for more lenient or harsher prosecution treatment before they ever enter the PTO.

<sup>177</sup> For a discussion of the rent-seeking problem, see Burk & Lemley, *Policy Levers*, *supra* note \_\_\_, at \_\_\_.

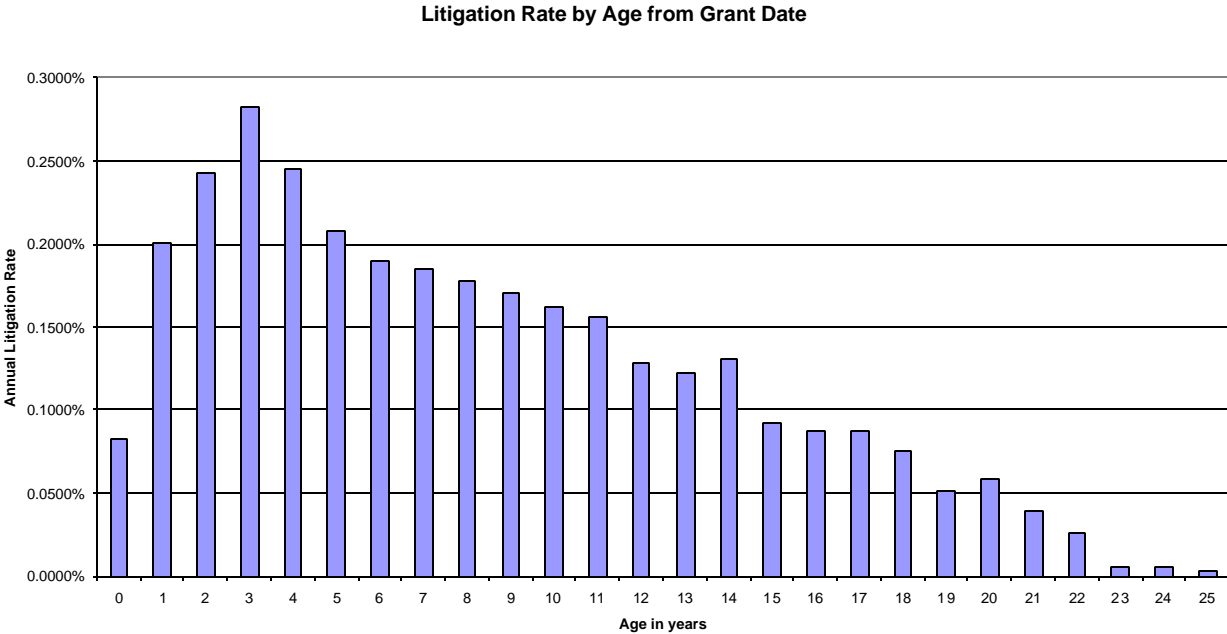


that obtain most patents are not the ones that tend to enforce them. Only if the patent system takes account of the realities of modern practice can we hope to achieve the ultimate goal of patents: encouraging innovation.

APPENDIX

Figure 1

Litigation Rate by Age



**Table 4****Logit Results for Large Population Study**

Model Information					
		Number of Observations	3971128		
		Missing Values	310718		
		Name of Distribution	LOGISTIC		
		Log Likelihood	-39589.06074		
Response Profile					
		Litigated	5729		
		Not Litigated	3965399		
Analysis of Parameter Estimates					
Variable	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-5.69500	0.05126	12344.0485	<.0001
age	1	-0.08079	0.0023365	1195.7321	<.0001
CLAIMS	1	0.01465	0.0006320	537.3528	<.0001
Chem	1	-0.39319	0.05435	52.3305	<.0001
CnC	1	0.42305	0.04690	81.3660	<.0001
DnM	1	0.57466	0.04701	149.4194	<.0001
EnE	1	-0.13531	0.05121	6.9827	0.0082
Other	1	0.27774	0.04246	42.7824	<.0001
CitMad	1	0.09144	0.0049245	344.7900	<.0001
CitRec	1	0.12079	0.0031594	1461.6305	<.0001
percfor	1	-0.86952	0.06188	197.4749	<.0001
inventrs	1	-0.07621	0.01105	47.5857	<.0001
Pyears	1	0.03236	0.0083005	15.2014	<.0001
USCorp	1	-0.31108	0.03444	81.5638	<.0001
ForCorp	1	-0.64808	0.06998	85.7556	<.0001
USInd	1	0.37148	0.10281	13.0561	0.0003
ForInd	1	0.02619	0.28366	0.0085	0.9264
USGov	1	-2.62359	0.37941	47.8172	<.0001
ForGov	1	-0.69588	0.41305	2.8383	0.0920

Table 5

## Multivariate Logistic Regression Results for Sample Study

Parameter	Estimate	Wald Chi-Square	Chi Square	Odds Ratio	Odds Ratio
			P value	Exp(Estimate)	Expressed as Percent
Intercept	-4.66	100.23	.0001	.009	-
NumTotalUSApps	.15	1.37	.2421	1.162	16.2
ForeignInventor	-1.56	40.28	.0001	.210	-79
NonProfitOwner	-.21	.07	.7909	.814	-18.6
IndividualOwner	1.04	23.88	.0001	2.821	182.1
Small_BusinessOwner	1.15	23.82	.0001	3.162	216.2
YrsPTO	.10	2.77	.0962	1.108	10.8
NumInventors	-.04	.32	.5689	.962	-3.8
CitationsReceived	.15	29.05	.0001	1.162	16.2
NumIndependent_Claim	.09	7.54	.0060	1.095	9.5
NumDependent_Claims	.01	3.05	.0807	1.013	1.3
NumUSPatentReference	.01	1.88	.1703	1.008	0.8
NumForeignPatentRefe	.00	.00	.9857	1.000	0
NumNonPatentReferenc	.02	5.18	.0228	1.021	2.1
TotalPatentsFromOrig	.03	.03	.8518	1.027	2.7
Num4DigitIPC	-.26	2.36	.1241	.769	-23.1
MedDev	-.64	3.77	.0521	.526	-47.4
Comp_Rel	.20	.35	.5541	1.218	21.8
Software	.28	.45	.5033	1.322	32.2
SemiCond	-.59	1.22	.2697	.555	-44.5
Electronics	.96	10.09	.0015	2.616	161.6
Chemistry	.86	6.86	.0088	2.364	136.4
Mechanics	1.57	31.24	.0001	4.818	381.8
AutoRel	-1.12	5.46	.0194	.326	-67.4
NumTotTechAreas	.61	9.67	.0019	1.837	83.7