Title
Who's Patenting What? An Empirical Exploration of Patent Prosecution

Author
Lemley, Mark A.

Publication Date
2000-06-01

Who's Patenting What? An Empirical Exploration of Patent Prosecution[1]

John R. Allison[2] & Mark A. Lemley[3]

Patents are big business. Individuals and companies are obtaining far more patents today than ever before.[4] Some simple calculations make it clear that companies are spending well over $5 billion a year obtaining patents in the U.S. – to say nothing of the costs of obtaining patents elsewhere, and of licensing and enforcing the patents.[5] There are a number of reasons why patenting is on the rise – primary among them a booming economy and a shift away from manufacturing and capital-intensive industries towards companies with primarily intellectual assets. But whatever the reason, it is evident that many companies consider patents important.

We set out to investigate who is patenting what: who is obtaining patents, in what areas of technology, and what characterizes those patents. To accomplish this, we took a random

---

2 Spence Centennial Professor of Business Administration, University of Texas Graduate School of Business.

3 Professor of Law, Boalt Hall School of Law, University of California at Berkeley; of counsel, Fish & Richardson P.C.

We would like to thank the U.S. Patent and Trademark Office (PTO) and in particular Justin Hughes and Jim Hirabayashi for allowing us access to small entity status records, Eric Forrest Allison and Brian Spross for research assistance, and Dr. Alex Chien for statistical advice and expertise.

4 U.S. PTO statistics indicate that they issued 163,209 patents in 1998, up from 124,146 in 1997. *See PTO Patents Up in 1998*, 57 **Patent, Trademark & Copyright J.** (BNA) 347 (Feb. 25, 1999). For recent data in representative years through 1995, see the Additional Information section of the PTO's 1996 Annual Report, see http://www.uspto.gov/web/offices/com/annual (visited Nov. 21, 1997). Data for those representative years are:

Year	US Pats	Foreign Pats	Total Pats	% Foreign
1983	32871	23989	56860	42.2%
1986	38126	32734	70860	46.2%
1989	50185	45354	95539	47.5%
1992	59760	49968	109728	45.5%
1995	64562	49679	114241	43.5%

5 *See* Mark A. Lemley, *Reconceiving Patents in the Age of Venture Capital*, 4 **J. Sm. & Emerging Bus. L.** __ (forthcoming 2000) (doing this calculation). This number also does not include the cost on the client side – just the cost of paying lawyers and PTO fees.

sample of 1000 utility patents issued between 1996 and 1998. We identified a large number of facts about each of these patents. In this article, we use this data to predict the characteristics of patents being obtained in the population as a whole. Further, we test a large number of relationships between these patents – how nationality relates to area of technology, how the size of the patentee relates to the prosecution process, and the like. In so doing, we hope to advance the understanding that both scholars and practitioners have about modern trends in patent prosecution.[6]

We proceed in four parts. In Part I, we survey the existing empirical literature on patents. In Part II, we explain the methodology of our study. We present the results of our study in Part III. Finally, we conclude in Part IV by highlighting some of the most significant findings in our data.

I. Existing Literature

The lack of empirical evidence on the function and impact of the patent system has long been lamented.[7] In recent years, a number of scholars have begun to address this deficiency in a variety of ways. This scholarship addresses three basic types of questions: (1) why people

[6] In a separate paper soon to come, we will conduct a study to determine how the characteristics of patents have changed over time. This forthcoming study will perform the same type of analysis as in the instant study, using, however, a randomly selected set of 1,000 patents in a 20-year-earlier two-year period (mid-1976 to mid-1978), and comparing the results of that study with the results of the present study.

[7] George Priest complained years ago that there was virtually no useful economic evidence on the impact of intellectual property. George Priest, *What Economists Can Tell Lawyers About Intellectual Property,* 8 RES. L. & ECON. 19 (1986). Fritz Machlup told Congress that economists had essentially no useful conclusions to draw on the nature of the patent system. *See* SENATE SUBCOMM. ON PATENTS, TRADEMARKS, AND COPYRIGHTS, SENATE COMM. ON THE JUDICIARY, 85TH CONG., AN ECONOMIC REVIEW OF THE PATENT SYSTEM 55 (Comm. Print 1958) (prepared by Fritz Machlup). For some of the disagreements among historians over the impact of the patent system on innovation, see ROBERT P. MERGES ET AL, INTELLECTUAL PROPERTY IN THE NEW TECHNOLOGICAL AGE 126-27 (2d ed. 2000).

These complaints may be unfair. As noted below, there is increasing attention in academic circles to the relationship between patents and innovation. Our study is one piece in this puzzle, albeit one focused on a portion of the problem that Priest might not consider the most important one.

patent, (2) what happens to patents after they are issued, and (3) what sorts of things are patented.[8]

First, several researchers have focused attention on how patents are perceived and used by firms in various economic sectors. The 1987 study by Levin, *et al*. is a prominent example.[9] There, the authors surveyed a large number of high-level R & D executives in over one hundred industries to identify preferences among patents, secrecy, lead time, and other methods of protecting the competitive advantages of important new processes and products. Although significant inter-industry variances were found, across industries patents were not viewed as the most effective means of encouraging innovation. Indeed, in some industries patents were considered the least effective contributor to innovation.[10] Other work explores trends in patenting in more detail on an industry-by-industry basis.[11]

---

[8] A fourth sort of work not catalogued here concerns the relationship between patents and economic development. For work along these lines, see Josh Lerner, *150 Years of Patent Protection* (working paper 2000); Z. Griliches, *Patent Statistics as Economic Indicators: A Survey*, 28 **J. Econ. Lit.** 1661 (1990).

[9] Richard C. Levin et al, *Appropriating the Returns from Industrial Research and Development*, 1987 BROOKINGS PAPERS ON ECON. ACTIVITY 783.

[10] *Id*. at 798. Not surprisingly, patents were viewed as much less effective for processes than for products. *Id*. at 794-95. Among the most important reasons found by the authors for the perceived limitations on the effectiveness of patents for were the ease of inventing around both process and product patents and doubts about patentability in the case of processes. *Id* at 803. Given their findings, the authors were led to question why firms patent so much, and at an increasing rate. Their research did not explore this question. However, a recent study by Cohen, *et al*., directly addresses this question. See Wesley M. Cohen, *et al*., *Appropriability Conditions and Why Firms Patent and Why They Do Not in the American Manufacturing Sector,* presented at the Stanford Workshop on Intellectual Property and Industry Competitive Standards, Stanford Law School, April 17-18, 1998. Before seeking to answer this question, the Cohen study updates that of Levin and finds that, across many manufacturing sectors, patents are viewed as substantially less effective for appropriating the value of product innovations than all other alternatives, secrecy and lead time being the most preferred alternatives. The study finds a number of reasons why firms nonetheless seek patents. Unsurprisingly, the most important reason given by respondents was to prevent others from copying. The authors recognize, however, that the importance of this reason could have been exaggerated because many respondents may have viewed this as the most "socially desirable response." The second most important reason was "blocking," or preventing other firms from patenting related technology. Blocking and related defensive motives may help explain the finding in our study that patent litigation commonly occurs long after the issuance of a patent. *See infra* notes __-__ and accompanying text. For another test of possible explanations why firms increasingly seek patents, see Samuel Kortum & Josh Lerner, *Stronger Protection or Technological Revolution: What is Behind the Recent Surge in Patenting?* (N.B.E.R. working paper, Sept. 1997). Kortum & Lerner reject the explanation that changes in patent law have prompted the surge in patenting.

Second, many studies have attempted to determine what people actually do with patents once they get them, and relatedly, how valuable those patents are. This class of studies has several parts. A growing number of scholars have attempted to value patents, either in absolute or relative terms, by reference to the use that is made of them by the patentee or the citations made to them by others.[12] Several other authors have evaluated patent acquisition and licensing strategies in various industries through case studies.[13] One especially interesting study of licensing by Josh Lerner in 1995 empirically examined the patenting behavior of 419 new biotechnology firms with varying litigation costs.[14] One of Lerner's key findings was that firms with relatively higher litigation costs are less likely to seek patents in those subclasses[15] in which

---

For other work along these lines, see, *e.g.,* Z. Griliches, Bronwyn H. Hall, & A. Pakes, *R&D, Patents and Market Value Revisited: Is there a Second (Technological Opportunity) Factor?*, 1 **Econ. Innov. & New Tech.** 183 (1991).

[11] *See, e.g.,* Bronwyn Hall & Rosemarie Ham Ziedonis, *The Patent Paradox Revisited: Determinants of Patenting in the U.S. Semiconductor Industry, 1980-1994* (working paper 1999); papers from Stanford conference.

[12] For an interesting approach to this question that accounts for the extent firms value patents by examining renewal data and multi-country filings, see Jean O. Lanjouw et al., *How to Count Patents and Value Intellectual Property: Uses of Patent Renewal and Application Data* (N.B.E.R. working paper, Sept. 1996). *Cf.* 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). For the patent citation approach, see, e.g., 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 Trajtenberg, *Market Value and Patent Citations: A First Look* (working paper 1998).

[13] Rebecca S. Eisenberg, *Public Research and Private Development: Patents and Technology Transfer in Government-Sponsored Research,* 82 VA. L. REV. 1663 (1996); Josh Lerner & Robert P. Merges, *The Control of Technology Alliances: An Empirical Analysis of the Biotechnology Industry*, 46 **J. Indus. Econ.** 125-156 (1998); Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839 (1990); Robert P. Merges, *Contracting Into Liability Rules: Institutions Supporting Transactions in Intellectual Property Rights*, 86 CAL. L. REV. 1293 (1996); David J. Teece, *Profiting From Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy,* 15 RES. POL. 285 (1986).

[14] Josh Lerner, *Patenting in the Shadow of Competition*, 38 J.L. & ECON. 463 (1995).

[15] The reference to subclasses is to sublevels within the patent classification system maintained by the United States Patent & Trademark Office (PTO). There are over 120,000 subclasses. Lerner's finding means that firms with relatively high litigation costs are more likely to use litigation-avoidance patenting strategies.

there had been many patent damage awards to rivals, especially to those with lower litigation costs.[16]

A smaller number of empirical studies have been conducted on patent litigation. These studies in turn take a variety of tacks. There are three comprehensive studies (including a recent one we conducted) on how patents fare in litigation.[17] Of the relatively few recent contributions to the empirical literature on patent litigation, the work by Lanjouw and Lerner on injunctive relief in patent cases is notable.[18] They evaluate a sample of 252 patent suits, testing the hypothesis that preliminary injunctive relief in patent litigation is used to impose costs on

---

[16] Lerner, *supra* note __, at 478-79. Using a number of ingenious data collection and testing methods, particularly in estimating relative litigation costs, Lerner contributes not only to the literature on patenting strategy but also to the literature on the various effects that litigation and other dispute resolution costs have on firms' behavior.

[17] Two of these studies cover relatively early periods. The first, by P.J. Federico, provided validity and infringement data for litigated patents reported in the *United States Patent Quarterly (U.S.P.Q.)* during the years 1925-1954, with more in-depth study of patents litigated during the years 1948-1954. Although Federico did not attempt to examine a large number of variables, he did examine overall validity rates in a relatively thorough manner, and in the 1948-1954 portion of the study he explored the courts' treatment of uncited and cited prior art. P.J. Federico, *Adjudicated Patents, 1948-54*, 38 J. PAT. OFF. SOC'Y 233 (1956). Federico found that courts upheld the validity of patents in only about 30-40% of the cases in which validity was an issue. *Id*. at 236. He also concluded that the prior art before the courts was often better that than used by the PTO in issuing the patent, based on his observation that accused infringers were generally more successful in convincing courts to invalidate patents on the basis of uncited prior art that on the basis of cited prior art. *Id*. at 249. Our data in a prior study confirm this observation, though the explanation Federico offers is by no means the only one. *See* John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 **AIPLA Q.J.** 185, 231-34 (1998).

The other study, first published by Koenig in 1974 and then updated through 1980, constitutes the most extensive set of data ever gathered on patent litigation. GLORIA K. KOENIG, PATENT INVALIDITY: A STATISTICAL AND SUBSTANTIVE ANALYSIS (rev. ed. 1980). Koenig also notes other early studies, but they appear to not add anything meaningful to the work of Federico and Koenig. KOENIG, *id*. at 3-4 to 3-10. Like Federico's data for 1925-1954, Koenig's data for 1953-1978 revealed that district and circuit courts found patents valid only about 35% of the time. Koenig collected all patent cases reported in the *U.S.P.Q.* in the years 1953-1978 to produce an array of descriptive statistics. She also selected a random sample of 150 patents from the years 1953-1967 for more in-depth study. In addition to finding that most courts held patents invalid, and noting the wide disparity of validity rates across regional circuits, she also found that obviousness (or "lack of invention") was the most frequently used basis for judicial invalidation of patents. *Id*. at 5-70 to 5-78. Koenig also studied the many kinds of prior art relied on by courts, and the ways in which uncited prior art played a role in the courts' decisions. *Id*. at 5-25 to 5-69.

The most recent comprehensive study is the one we conducted in 1998 covering all final written decisions on patent validity from 1989 through 1996. *See* John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 **AIPLA Q.J.** 185 (1998).

[18] Jean O. Lanjouw & Josh Lerner, *Preliminary Injunctive Relief: Theory and Evidence From Patent Litigation* (N.B.E.R. working paper, July 1996).

rivals.[19] Coolley has also produced a useful empirical study of a purely descriptive nature on patent infringement damages.[20] Lanjouw and Schankerman evaluate data provided by the PTO about litigated patents to determine the ways in which litigated patents differ from the general patent pool.[21] At least two other studies[22] have attempted, with mixed success, to empirically analyze the decision-making behavior of the United States Court of Appeals for the Federal Circuit.[23]

---

19 *Id*. Lanjouw and Lerner find that their data is consistent with the hypothesis that preliminary injunctive relief is a predatory weapon in patent cases.

20 Ronald B. Coolley, *Overview and Statistical Study of the Law on Patent Damages*, 75 J. PAT. & TRADEMARK OFF. SOC'Y 515 (1993). This study analyzed several factors from 152 decisions between 1982-1992 in which the amount of damages was reported. Although unstated in the article, it appears that both district court and Federal Circuit decisions were included. The article also did not define the source of its data set, but apparently included decisions reported in West reporters, U.S.P.Q., and Lexis.

21 Jean O. Lanjouw & Mark Schankerman, *Stylized Facts of Patent Litigation: Value, Scope and Ownership* (working paper 1997).

22 Ronald B. Coolley, W*hat the Federal Circuit Has Done and How Often: Statistical Study of the CAFC Patent Decisions—1982-1988*, 71 J. PAT. & TRADEMARK OFF. SOC'Y 385 (1989); Donald R. Dunner, *et al*., *A Statistical Look at the Federal Circuit's Patent Decisions: 1982-1994*, 5 FED. CIR. B.J. 151 (1995).

The Coolley study of Federal Circuit decision making is quite difficult to use as a basis for any type of conclusion. It did not identify the source of its data, did not attempt any kind of precise definition of its data set, and has a number of data comparability problems. Some of these problems stem from the inclusion of design patent decisions, decisions on appeal from all lower tribunals over which the Federal Circuit has appellate jurisdiction, and inclusion of all subjects of Federal Circuit decision and all types Federal Circuit judgments.

The study by Dunner, *et al*., on the other hand, provides much more useful descriptive statistics. This research had the avowed objective of determining whether the Federal Circuit was "biased" in favor of patents. Specifically, Dunner examines whether the Federal Circuit is generally more pro-patent than its predecessor patent appeals courts, namely, the regional circuits and the Court of Customs and Patent Appeals (C.C.P.A.). Dunner's study was based on 1302 Federal Circuit decisions of all kinds, many unreported; the source of the data set is not clear. Although the study was based on a very large data set that may present data comparability problems, one portion of it did segregate Federal Circuit decisions on patent validity. Like other studies of the Federal Circuit, the Dunner study found a much higher validity rate than had been found in district court and regional court of appeals decisions prior to the Federal Circuit's creation. This was found to be true both overall and with respect to the individual grounds of novelty/statutory bars, obviousness, and description and claim adequacy. *Id*. at 154.

23 Congress created the Federal Circuit in 1982 to serve, *inter alia*, as the only United States court of appeals to review district court patent cases. Although not relevant to our study, the same legislation also gave the newly created Federal Circuit appellate jurisdiction over appeals from decisions of the Patent and Trademark Office's Board of Patent Appeals and Interferences in instances where the Board had affirmed the patent examiner's rejection of a patent application. This latter form of appellate jurisdiction had previously been within the province of the C.C.P.A, the existence of which was extinguished by the 1982 legislation. Federal Courts Improvement Act of 1982, P.L. 97-164, 96 Stat. 25, 37 (codified as amended at 28 U.S.C. § 1295 (1994)).

Finally, there is a small body of empirical work on patent prosecution – the field to which this article contributes. This work attempts to define and explain the characteristics of patents themselves, rather than (as with the studies described above) why they are obtained or how they are ultimately used. Some of these studies are industry specific. For example, Daniel Johnson has studied aspects of the prosecution process in the specific context of biotechnology patents, evaluating in one particular industry many of the characteristics we examine here across all industries.[24] Other studies cut across industries, but study only one particular aspect of the prosecution process.[25] To our knowledge, however, ours is the first comprehensive study of the relationship between multiple characteristics of patents across all major areas of technology.

II. Description of the Study

We collected a random sample of 1,000 utility patents issued in the United States during a two-year period in 1996 and 1998. Starting with the patent having the first number issued in the first week of June, 1996, and ending with the patent having the last number issued in the last week of May, 1998, we then used a random-number generator to select a random sample of 1,000 patent numbers from this population.[26]

For each patent in the sample, we obtained a wide variety of information:

- PTO classification number and PTO technology group (mechanical, chemical, or electrical);

---

[24] *See* Daniel K.N. Johnson, *Biotechnology Inventions: What Can We Learn From Patents?* (working paper 2000).

[25] *See, e.g.,* Mark A. Lemley, *An Empirical Study of the Twenty-Year Patent Term*, 22 **AIPLA Q.J.** 369 (1994); Chris L. Holm, *Patent Prosecution Comparison Between the United States Patent and Trademark Office and the European Patent Office*, 25 **AIPLA Q.J.** 233 (1997) (both studying time spent in prosecution).

[26] When a sample is truly random, the larger the sample the more likely it is to include duplicate numbers. Knowing that this would be the case with a sample of 1,000, we actually selected an initial sample of 1,050. Fourteen of the numbers were duplicates, and were discarded. We then substituted the next 14, i.e., randomly generated numbers 1,001-1,014. The remainder of the 1,050 were discarded. Not only was this method a matter of necessity, but it also does not affect the randomness of the sample.

- area of technology, among the 14 technology groups we defined, and number of technology areas into which each patent fell;[27]
- country of the invention's origin;[28]
- filing date, U.S. and foreign priority dates, issue date, and time spent in prosecution;[29]
- the number and type of filings to which each patent claimed priority, if any;
- small entity status and type, and large entity status;
- the number of inventors;
- whether the patent had been assigned;
- whether the patent had a foreign assignee, and whether it had at least one foreign inventor;
- the number and type of prior art references cited on the face of the patent; and
- the number and type of claims contained in the patent.

Most of this data was available in the patent itself, or easily derived from information in the patent. There were two major exceptions. First, because we found the PTO's subject matter classification scheme inadequate for our purposes, we have attempted to classify the patents in our sample into areas of technology that we have defined ourselves. Second, information on the nature and size of the individual or entity that owns the patent is not available on the face of the patent itself. However, patentees are required to file either small or large entity status with the PTO; the size of the entity determines the fees they pay.[30] Small entities are further divided into

---

[27] For more information on how we defined these groups, see *infra* notes __-__ and accompanying text.

[28] For more information on how we defined country of origin, see *infra* notes __-__ and accompanying text.

[29] Time spent in prosecution was determined by subtracting the first U.S. priority date from the issue date.

[30] The report is made by the applicant, and is not verified by the PTO. **U.S. Patent & Trademark Office, Manual of Patent Examining Procedure** §509.03. Misrepresenting entity size is illegal and can theoretically invalidate the patent. *See* 37 C.F.R. § 1.9(f); *cf.* DH Technology Inc. v. Synergystex Int'l, 154 F.3d 1333 (Fed. Cir. 1998) (innocent failure to pay large entity fee can be corrected later). Thus, there is some reason to believe these self-reports are accurate.

three categories: individuals, non-profit organizations, and small businesses.[31] This data is not published. However, the PTO generously agreed to provide us with the data for the 1,000 patents in our study.

Regarding our attempt to define areas of technology, one must understand that the act of defining areas of technology in today's world is as much art as it is science. Some might reasonably disagree with some of our definitions; although almost all of our fourteen areas are susceptible to more than one definitional approach, we believe ours to at least as reasonable as other possible alternatives. Following are the definitions of technology areas employed in this study, listed in the order in which they were in which they appeared in our spreadsheet columns.

(1) Pharmaceutical: Any process or substance to be used in the diagnosis or treatment of diseases or other medical conditions in humans or animals; it also includes processes or substances used in medical research. In this data set, a technology classified as Pharmaceutical will also be within either the Chemistry or Biotechnology areas.[32]

(2) Medical device: An apparatus to be used for the diagnosis or treatment of diseases in humans or animals; it also includes apparatuses used in medical research. An invention classified as a medical device will necessarily fall within at least one other classification, such as computer-related, electronics, mechanics, acoustics, or optics.

(3) Biotechnology: Any process or product involving advanced genetic techniques intended to construct new microbial, plant or animal strains.

---

[31] 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.

[32] In an almost identical study we are doing on 1,000 randomly selected patents from mid-1976 to mid-1978, with the objectives of separately analyzing that 20-year-earlier data set and comparing those results with the results from this study, all of the patents classified as Pharmaceutical were also classified as Chemistry, but none was also classified as Biotechnology, presumably because the science was still in its infancy at that point.

(4) Computer-Related: (a) Any process or product for improving computer hardware (except for advances in semiconductor technology, which are in a separate, mutually exclusive classification). (b) An invention solely embodied in software. (c) Any invention in which a microprocessor or other integrated logic circuit is expressed in the patent as being a critical part of the invention (again excluding advances in semiconductor technology itself). Any invention in part (c) of the Computer-Related classification will necessarily also be classified in one or more other categories.

(5) Software: An invention that is completely embodied in software. A pure software invention is also placed in the Computer-Related classification. The instructions embodied in software code can often be embodied in semiconductor chips in a device; this is done in the obvious instances of modern consumer electronic devices, automobiles, and other devices in which the instructions are very specific to a particular function of the device and the use of software for logic instructions simply is not practically feasible. Another researcher might include within the Software classification those inventions in which the algorithms are embodied in chips, but we have chosen to include within our definition of Software only those inventions that consist purely of software that is not embodied in hardware.

(6) Semiconductor: A process or product intended to advance the state of the art in researching, designing, or fabricating semiconductor computer chips.

(7) Electronics: A process or product in which the sole or a critical part of the invention makes use of traditional electronic circuitry or involves electric energy storage. An invention in this classification may also be included in other classifications, including chemistry, mechanics, or optics.

(8) Chemistry: A process that consists solely of chemical reactions, a product resulting from such a process, or an invention of which a chemical process or product is a critical part. An invention in the field of chemistry may sometimes be included in one or more other classifications, such as electronics or optics.

(9) Mechanics: A process or product that consists solely of the use of mechanical parts, sometimes combined with heat, hydraulics, pneumatics, or other power sources; also an invention in which the above is a critical part. Some inventions classified as mechanical also will be in one or more other classifications, such as electronics (there continue to be quite a few electro-mechanical inventions in which both the electronics and the mechanics are critical parts).

(10) Acoustics: A process or product that consists solely or as a critical part of an invention using sound waves. Such an invention sometimes may also be included in another classification, such as medical device or computer-related.

(11) Optics: A process or product intended to advance the state of the art in the use of light waves or imaging. This may be its sole purpose or it may be a critical part of an invention also having other purposes. Optics technology often will also be classified in one or more other areas, such a medical devices, semiconductors, electronics, or chemistry.

(12) Automotive-related: As expressed in the patent, an invention that is intended for use with automobiles or trucks. An invention in this classification necessarily will also be included within another classification, such as mechanics, electronics, or even computer-related.

(13) Energy-related: As expressed in the patent, an invention that intends to advance the state of the art in the production, processing, or transmission of energy. An invention is also included in this classification if its intended use is research into some aspect of the production, processing, or transmission of energy. The definition of "energy" includes that *produced by any*

means from any source, including fossil fuels, nuclear power, electricity produced, and the many forms of radiation. An invention in this classification necessarily will also be included within another classification, such as mechanics, electronics, acoustics (*e.g.*, seismological inventions for detection of oil and gas), optics, chemistry, and even computer-related.

(14) Communications-related: As expressed in the patent, any invention intended to improve the state of the art in communications. As in the other broad classifications (computer-related, automotive-related, and energy-related, an invention placed in this classification necessarily will also be included within another classification, such as optics, electronics, or computer-related.

We separate our results into two parts. In the first part, we use our sample as a tool to describe the approximate characteristics of the larger population of issued patents.[33] Because our study covers only a sample, it cannot predict with perfect accuracy the characteristics of the population as a whole. However, because the sample size is random and so large, the "confidence intervals" – the range within which we can be 95% (or 99%) confident the actual number will fall – are quite small. In describing our results in this first part, we have chosen to omit reference to the exact confidence intervals unless they are important to the conclusions we identify. We do of course have the confidence intervals in our data set, and will make them available to scholars along with the larger data set.

The second and larger set of results involves the evaluation of relationships between different aspects of this data. We have taken most of the characteristics identified in the first part

[33] More precisely, we are predicting the characteristics of the population we have defined, which is utility patents issued in the United States during the mid-1996 to mid-1998 time period. These results will not necessarily be predictive of patents issued outside that time period.

and related them to each other. These relationship tests are all bivariate, not multivariate. Thus, we can predict with confidence that two characteristics are related to each other (say, country of the invention's origin and mean time spent in prosecution). However, it is likely that other factors (say, area of technology or number of applications filed) contribute to explaining this relationship. Thus, we wish to emphasize that we are *not* predicting cause and effect, merely correlation.

III. Results

We present our results in two broad categories. In section A, we present the characteristics of the sample that we have catalogued, such as country of origin, area of technology, time spent in prosecution, and the like. This section gives the reader a good understanding of who is patenting what. In section B, we relate these characteristics to each other, seeking patterns that may illuminate important facts about patent prosecution.

A. Characteristics of Issued Patents

As noted above, we collected a variety of facts about each issued patent in the sample. These facts include: area of technology, country of origin, the presence or absence of foreign priority, the number of prior U.S. filings, the time spent in prosecution, the nature and size of the entity prosecuting the patent, the number of inventors, whether or not the invention was assigned, whether the inventor or the assignee were foreign, the number and type of references cited in the patent, and the number and type of claims in the patent. In this section, we use this data to predict the descriptive characteristics of the larger population of patents issued during 1996-1998. We describe the results of this analysis in the sections that follow.

1. Area of Technology

We used two different measures of area of technology. First, we used the PTO's classification system, which divides each patent into the categories "Mechanical, Chemical, and Electrical". Second, we also constructed our own set of fourteen technology categories by examining each patent in detail.

The PTO classification system shows a roughly even division into its traditional categories. Of the 1000 patents in the study, the PTO classified 374 as "mechanical," 292 as "chemical," and 334 as "electrical." This is roughly consistent with prior data, though the numbers in our sample contain somewhat more electrical patents than in prior studies.[34] This may reflect a growing trend towards patenting in certain fields the PTO generally classifies as electrical, such as computer software.

We were not content to rely on the PTO classification system, however, for two reasons. First, we did not find it particularly reliable. In the course of this study, we came upon numerous instances of what appear to us to be wrong or arbitrary classification decisions.[35] Second, the PTO system groups together technologies that may have very different characteristics. For example, pharmaceutical, petroleum, and biotechnology inventions would all be classed as "chemical" under the PTO system, even though the industries in question are very different.

[34] A study of 2,081 patents issued in 1994 found that 874 were classified by the PTO as mechanical, 604 as chemical, and 603 as electrical. *See* Mark A. Lemley, *An Empirical Study of the Twenty-Year Patent Term*, 22 **AIPLA Q.J.** 369, 388 Table 2 (1994). 29.0% of the patents in that study were classified by the PTO as electrical, and 29.0% as chemical. In our current study, by contrast, using patents issued from 1996 through 1998, a virtually identical 29.2% of the patents are chemical, but 33.4% are electrical.

[35] Two of the many examples follow: (1) Pat. No. 5,525,451, "Photoreceptor Fabrication Method," issued June 11, 1996. The PTO placed the patent within its Mechanical category, but a reading of the patent reveals that it does not intend to advance the state of art in Mechanics; instead, the patent clearly reveals that the inventors objective was to advance Optics and Computer-Related technologies. (2) Pat. No. 5,539,844, "Ball Bearing Cages and Ball Bearings," issued July 23, 1996. The PTO placed the patent within its Electrical category, when even a casual reading of the patent reveals that it had nothing at all to do with electronics, but instead was purely mechanical.

This problem is exacerbated by the problem of inventions that cross over between industries, such as bioinformatics or computer-controlled mechanical devices.

To deal with these problems, we designed a classification system that is more finely graded than the PTOs. Further, we were willing to class a particular patent in more than one category where necessary.[36] The results of this classification system are presented in Table 1, sorted by frequency.

Table 1
Technology Areas Sorted by Frequency

Mechanics	329
Computer-Related	242
Chemistry	207
Optics	128
Semiconductors	93
Pharmaceuticals	78
Electronics	77
Software	76
Automobile-Related	72
Medical Devices	64
Communications-Related	41
Biotechnology	37
Energy-Related	24
Acoustics	22

Even as broken down more finely, one thing that is striking about these results is how many patents issue for truly mechanical inventions: 329 out of 1,000 patents, or nearly one-third, were mechanical inventions. It is also notable how many inventions are in the general field of computer-related inventions: 242, or nearly one-quarter, including 76 software inventions.[37]

[36] Indeed, this was quite common. The 1,000 patents we studied produced 1,489 total technology areas, or an average of nearly 1.5 areas per patent. Some patents were classed in as many as four different areas. *See* Table 1.

[37] Our definition of a computer-related invention, recited *infra* along with our definitions of other technology areas, must be treated with care. For example, a software invention was also classified as computer-related and should not be added to the computer-related category for the purpose of arriving at a total number of patents in the computer area. Also, as noted *infra*, semiconductor inventions were *not* included with the computer-related classification, but were included in a separate, mutually exclusive category, and appropriately could be added to the computer-related category for the purpose of arriving at a total number of patents in the general computer area.

Finally, a significant number of patents were granted in areas that some readers might find somewhat surprising—128 in optics and 22 in acoustics—probably because the media generally do not pay much attention to optics or acoustics in their reporting on booming technology areas. Most scientists know better, however, and non-scientists also will if they just think "lasers," "fiber optics," or "ultrasound."

Assuming these numbers are representative of patents issued generally during this time period,[38] there are an enormous number of patents in force in many of these fields of technology. Approximately 237,297 patents were granted in the United States during the two years of our study (June 1996 - May 1998).[39] Of these patents, our sample predicts that approximately 22,068 are semiconductor patents, and 18,035 are software patents.[40] And of course these are only a small fraction of the patents currently in force in the U.S.; many more semiconductor and software patents doubtless issued in the periods before June 1996 and since May 1998.[41]

2. Country of Origin

We also classed each patent by country of origin. Twenty-five countries were represented in our sample; of these, 12 had five or more patents issued (representing ½ of one

---

38 They should be, given the randomness of the sample and the large sample size. *See, e.g.*, AMIR D. ACZEL, COMPLETE BUSINESS STATISTICS 180-206 (1989) (discussing confidence intervals and their measurement in several sets of conditions).

39 A total of 369,149 patents were granted in the United States during the years 1996-1998. *See* U.S. Patent & Trademark Office, All Technologies Report, Table A1 (March 1999). Because our study covered only 24 months during those years, we have included in the number in text all of the 111,983 patents granted in 1997, 7/12 of the 109,646 patents granted in 1996, and 5/12 of the 147,250 patents granted in 1998.

40 These numbers are generated by multiplying the percentage of the sample composed of each type of patent by the total number of patents issued during this two-year period.

41 Greg Ahronian estimates that there are now 80,000 software patents in force in the United States. Greg Ahronian, *Internet Patent News Service*. While our numbers may be slightly more conservative than his, that estimate is not unrealistic.

percent or more of the total).[42] In defining "country of origin," we were concerned with identifying the nation in which the invention itself originated. Our decision model focuses first on the domicile of the inventor at the time the patent issued. If two or more inventors from different nations were listed, we chose the country in which a majority of the inventors were domiciled. This initial step in our decision model determined the country of origin in almost all cases. In those few instances in which there were multiple inventors with different domiciles and no nation of domicile constituted a majority, we looked at the nation having the largest plurality of common inventor domiciles and chose that nation if either the assignee-at-issue or the nation in which the patent application was first filed was the same as the inventor-domicile plurality. This latter approach also was used in the one or two instances in which there were multiple inventors, all with different national domiciles; if the domicile of one of the inventors was the same as the domicile of the assignee-at-issue, that nation was chosen. In this rare type of situation, we did not encounter a patent in which there was no common domicile between any inventor and the assignee-at-issue. If such an instance had occurred, we would have chosen the nation of first filing if it corresponded to the domicile of an inventor; if this did not finally resolve the question, we would have simply chosen the nation in which the assignee-at-issue was domiciled.[43]

Summary results for those twelve countries having five or more U.S. patents in our sample are presented in Table 2, organized by number of patents granted.

---

[42] The countries with less than five patents in the sample were the Cayman Islands (1), Hong Kong (2), Singapore (2), India (1), Ireland (2), Austria (1), Belgium (3), Sweden (4), Norway (2), Finland (3), Denmark (2), Israel (3), and the Czech Republic (1).

[43] This decision model looks much more complicated than it really is because we wanted at the outset a decision model for nation of origin that would cover all possibilities. Also, as noted in the text, the initial part of the model, focusing solely on the inventors' domicile, resolved the issue in a very high percentage of patents.

Table 2
Patents Granted By Country of Origin

United States	540
Japan	212
Germany	66
France	31
South Korea	25
Taiwan	24
United Kingdom	19
Canada	17
Italy	13
Netherlands	12
Switzerland	8
Australia	6

These numbers are consistent with those identified by the PTO for the population of patents issued during this period.[44] What is most notable about these numbers is how few countries are represented on this list. The twelve countries listed in Table 3 together account for 97.6% of all patents issued in the sample. Of these, the U.S. accounts for more than half, and the U.S. and Japan together for more than 75%. Further, there were almost no patents issued on behalf of inventors in countries outside of North America, Europe, and the Pacific Rim, as demonstrated in Table 3.

[44] *See* U.S. PTO, *supra* note __, at Table A1-2. Slight discrepancies result from the imperfection of prediction of population characteristics from even a large sample, see *supra* note __ and accompanying text, and from the slightly different definitions of "country of origin" used by the PTO. The PTO defines "country of origin" to be the residence of the first-named inventor at the time the patent is issued. Although obviously easier than the approach we used to determine country of origin, *supra* text accompanying notes 41-42, it is a very crude method and is more likely than not to misrepresent the actual country in which the invention originated. By contrast, we developed a much more logical and refined method for determining the country in which the invention originated. *Id*.

Table 3
Patents By Region

North America[45]	557
Pacific Rim[46]	271
Europe[47]	167
TOTAL	995

There were virtually no patents issued to inventors in the developing world, with the exception of what might be termed the "Asian tiger" economies (Korea, Taiwan, and Singapore).

We also examined each patent for the presence of one or more foreign inventors, and for foreign assignees. A very substantial 481 of the 1,000 patents had at least one foreign inventor. This includes at least some patents that we classed as being of U.S. origin, because of cross-national inventorship. A similarly substantial 394 patents were assigned to foreign corporations, approximately 85.6% of the 460 patents we determined to be of foreign origin. This number is virtually indistinguishable from the percentage of assignments in the sample as a whole (85.1%), suggesting that foreign patents are no more likely to be assigned to corporate owners than domestic patents.

3. Nature of Inventors and Owners

We also studied a number of characteristics about inventors and patent ownership, including the number of inventors, whether the invention was assigned, and the small entity status of the patent owner. These characteristics belie the traditional (and once-accurate) notion of the typical inventor as an individual working alone in his garage. Today it is overwhelmingly

45 Includes the U.S. and Canada.

46 Includes Japan, Korea, Australia, Taiwan, Hong Kong, and Singapore.

47 Includes the U.K., Ireland, Germany, Austria, France, Italy, Switzerland, the Netherlands, Belgium, Sweden, Norway, Finland, Denmark, and the Czech Republic.

large corporations who are obtaining patents.[48] At the same time, however, the individual inventor is far from being a myth.

Most inventions in our study are not developed by a single individual. On average, each patent in our sample listed 2.26 inventors; the median patent listed two inventors. At the extreme, one patent listed as many as eleven inventors. While inventive collaboration is certainly possible between individuals, it is one of the hallmarks of "big science" at major corporations. Further, those inventors assigned their patent rights to a corporate entity (typically but not necessarily an employer) in an overwhelming 851 out of 1,000 cases. Finally, the PTO divides patentees into "large entities" and "small entities," the latter a category that includes individuals and non-profit corporations as well as small businesses. Of the 1,000 patents in our sample, 707 were assigned to large entities at the time of issuance.[49] Of the 293 small entities, 118 were organizations (11 non-profit organizations and 107 small businesses). The remaining 175 patents were prosecuted by individuals.

4. The Prosecution Process

Finally, we collected a variety of data about the prosecution process of the patents in the sample. Specifically, we studied the time spent in prosecution, the total number of continuations, CIPs[50] and divisionals filed by the applicant, whether they claimed priority to a foreign application, the number and type of prior art references cited in each patent, and the number of claims in each patent.

---

48 This supposition is borne out by the PTO statistics, which identify the entities – mostly large companies -- that own the most patents. *See* U.S. PTO, *supra* note __, at Table B.

49 Patents are always issued in the name of the individual inventor or inventors. *See* 35 U.S.C. § 115, 116. Thus, a large entity that owns a patent must have received it by assignment from the inventor, or by some comparable mechanism of implied assignment. *See, e.g.,* 35 U.S.C.§ 118, 261.

50 Continuations-in-part.

On average, the patents issued in our sample spent 1,011 days, or 2.77 years, in prosecution from the filing of the *first* U.S. application to the issue date. The median patent spent rather less time in prosecution: 811 days, or 2.22 years. The range of prosecution times varied widely, from a low of 1.16 years to a high of 18.15 years. The mean prosecution time in this sample is somewhat longer than that found in a study of patents issued in 1994. That study found a mean prosecution time of 864 days, or 2.37 years.[51] Thus, it would appear that patents issued in the 1996-1998 period took longer to get through the patent office than in 1994, the opposite result from that predicted by Lemley in 1994.[52]

It is not clear what explains this change, but we note two possible factors. First, the last several years have seen a dramatic increase in the number of patent applications filed and patents issued. In 1998, 243,062 patent applications were filed in the U.S., an increase of 39.1% over the number filed five years earlier in 1993. The patent office issued 147,520 patents in 1998, a 45.4% increase over the number issued just three years earlier.[53] Thus, it may not be surprising that pendency times have increased, given that the workload of Examiners has increased.

Second, a significant change in the patent term went into effect for applications filed beginning June 8, 1995. Applications filed after that date were treated under the 20-year patent term, while applications filed before that date got the benefit of the longer of patent terms calculated under the 17 and 20-year rules.[54] Because of uncertainty about patent term under the 20-year rule, a larger-than-normal number of patent applications were filed in the weeks

---

[51] *See* Lemley, *supra* note __, at 386 & Table 1.

[52] *See id*. at 385-87 (predicting a 20% drop in pendency times). Since many of the patents in our study issued on applications originally filed before 1995, however, Lemley's arguments may still be valid, and may simply not have had time to take effect.

[53] U.S. PTO, *supra* note __, at Table A1.

[54] For detail on this change, see Lemley, *supra* note __.

preceding the cut-off date.[55] Because that cutoff date occurred in the midst of when the applications in this sample were filed, these new filings may affect the characteristics of the sample somewhat. In particular, anyone engaged in the practice of "submarine patenting" (deliberately delaying the issuance of a patent in order to take a mature industry by surprise years later) would have a strong incentive to get their patent or CIP on file before June 8, 1995, in order to take advantage of the old 17-year patent term. This may in turn result in a sample that is not truly representative, in that it contains a larger number of long prosecution periods than one would normally expect. However, while there may be some difference, we do not think it can fully explain the result in this study.[56]

We also examined a number of other factors relating to patent prosecution. Patent applicants in our sample frequently relied on prior applications (called parent or grandparent applications) for priority in the patents that ultimately issued. These priority claims fell into two categories. First, 394 of the 1,000 patents claimed priority under an international treaty based on a prior application filed outside the United States. Since 460 patents originated outside the U.S., this means that at least some foreign-owned patents were filed first in the U.S. rather than at home. Second, a significant minority of the patentees in the sample based their priority on a prior U.S. application. Thus, 159 of the patents claimed priority via at least one continuation

---

55 In our sample, 32 applications claim a priority date between May 22, 1995 and June 8, 1995, while only 11 claim a priority date during a comparable period eight months earlier (September 22 to October 10, 1994). Similarly, 83 applications in the sample had at least one filing date (though not necessarily a priority date) during this period, compared with 15 in the period eight months earlier.

56 One partial test of this hypothesis is to compare the difference between the mean and median prosecution times in our study to the difference in the 1994 study. The more days by which the mean exceeds the median, the more the mean has been increased by an asymmetric "tail" of patents that spent an extremely long time in prosecution. The (mean – median) difference in the 1994 study was 163 days, see Lemley, *supra* note __, at Table 1, while in our sample it is 200 days. In percentage terms, however, the difference is minimal (23.3% of the median time in prosecution in 1994, compared to 24.7% in our sample).

application, 111 via a CIP application, and 99 via a divisional application.[57] On average, the total number of U.S. applications in a priority chain (including the one that ultimately resulted in a patent) was 1.50. While the median patent did not claim priority, some patents claimed priority based on as many as nine different applications. On the other hand, a plurality of patents (410) did not claim priority to any previously filed application, at home or abroad.

The patents in our sample made reference to an average of 15.16 total pieces of prior art. The median patent cited 10 prior art references; patents issued citing anywhere from a low of zero prior art references to a high of 163 references. The data are presented in Table 4.

Table 4

Prior Art References

Prior Art	U.S. Patent Refs	Foreign Patent Refs	Non-Patent Refs	Total Refs
Mean	10.34	2.44	2.37	15.16
Median	7	1	0	10
Min	0	0	0	0
Max	137	43	68	163

We divided those references into three categories of prior art, also noted in Table 4: prior U.S. patents, prior patents from outside the U.S., and non-patent prior art. Citations in the sample were overwhelmingly made to U.S. patents – on average, each patent cited 10.34 prior U.S. patents, compared with only 2.44 foreign patents and 2.37 non-patent references. Indeed, the median patent cited *no* non-patent prior art at all. The absence of non-patent prior art is particularly striking, given that in many areas of technology other patents may not be the best source of prior art.[58] The predominance of U.S. patents may also reflect the limitations of the

[57] Because some but not all of the patents used more than one type of priority mechanism, we cannot merely sum these numbers to determine the number of patents relying on prior U.S. applications.

[58] *See* 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 Ahronian, Internet Patent

PTO systems for searching: the PTO is much more likely to find documents that it itself has generated.

Finally, we also investigated the number of claims filed in each patent. On average, patents in the sample had 14.87 claims. The median patent had 12 claims, but patents had as few as one claim and as many as 120. The vast majority of these claims were dependent; the median patent had only two independent claims (though some patents had as many as 24). These data are summarized in Table 5.

Table 5

Number and Type of Claims

Claims	Independent	Dependent	Total
Mean	2.75	12.12	14.87
Median	2	10	12
Min	1	0	1
Max	24	115	120

B. Relationships Among the Data

We conducted statistical tests on a number of relationships between the characteristics we have identified.

1. Relationships Between Technology and Nation of Origin

We found significant differences between the technologies patented by inventors in different countries. We tested these relationships in a number of ways. First, we examined the breakdown of inventions into the PTO categories of mechanical, chemical and electrical for each country with ten or more patents. The results are presented in Table 6.

News Service, http://www.bustpatents.com (arguing that software patents are of doubtful validity because they cite very little non-patent prior art).

Table 6

Technology Divisions by Country of Origin[59]

Q1	US	Canada	Japan	Korea	Australia	Taiwan	UK	Germ.	France	Italy	Switz.	Neth.	Total
Mech	223	10	45	7	6	17	8	26	10	5	5	5	356
Chem	162	4	55	3	1	2	7	26	11	4	1	2	273
Elec	155	3	112	15	2	5	4	14	10	4	2	5	327
Total	540	17	212	25	9	24	19	66	31	13	8	12	959

Q1 %	US	Canada	Japan	Korea	Australia	Taiwan	UK	Germ.	France	Italy	Switz.	Neth.
Mech	41.30%	58.82%	21.23%	28.00%	66.67%	70.83%	42.11%	39.39%	32.26%	38.46%	62.50%	41.67%
Chem	30.00%	23.53%	25.94%	12.00%	11.11%	8.33%	36.84%	39.39%	35.48%	30.77%	12.50%	16.67%
Elec	28.70%	17.65%	52.83%	60.00%	22.22%	20.83%	21.05%	21.21%	32.26%	30.77%	25.00%	41.67%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

59 The totals in the last column do not add to 1000 because we have omitted from Table 7 some countries that had fewer than 5 U.S. patents in our sample.

Some differences are evident from this data. Compared to the overall numbers (37.4% mechanical, 29.2% chemical, and 33.4% electrical), United States' inventors patents somewhat more mechanical inventions, and somewhat fewer electrical inventions. Other countries patenting more mechanical inventions than average (and fewer electrical inventions) include Canada, Taiwan, and the U.K. By contrast, Japan and Korea both patented far more electrical inventions than average, and fewer mechanical and chemical inventions. When patents from outside the U.S. are aggregated, the result on balance is that non-U.S. patents were somewhat less likely than U.S. patents to be mechanical (32.8% outside the U.S., compared with 41.3% within the U.S.), and somewhat more likely to be electrical (38.9% outside the U.S., compared with 28.7% within). We tested both of these relationships for statistical significance, and determined that there is a strong, statistically significant relationship between PTO subject matter classification and country of origin.[60]

Because as noted above the PTO's subject matter classifications are unreliable, we also tested the relationship between country of origin and each of the fourteen areas of technology we have defined for this study. The results are presented in Table 7.

---

[60] We conducted a Chi-square test of homogeneity in both cases, which found significant differences in PTO subject matter class both between foreign and U.S. patents, and country by country.
Test Result:
Foreign vs. US:

Statistic	DF	Value	Prob
Chi-Square	2	12.837	**0.002**

Country-by country:

Statistic	DF	Value	Prob
Chi-Square	22	79.595	**0.001**

On the Chi-square test of independence, see, *e.g.,* **Michael O. Finkelstein & Bruce Levin, Statistics for Lawyers** 159-165 (1990).

Table 7

Areas of Technology by Country of Origin

Q3	Pharm	Med.Dev.	BioTech.	Comp-Rel.	Software	SemiCond.	Electronics	Chemistry	Mechanics	Acoustics	Optics	Auto-Rel	Energy-Rel	Commun-Rel	Total
US	48	48	31	121	40	46	35	105	194	11	51	31	14	25	800
Canada	2	0	0	3	1	0	3	4	7	0	3	1	1	0	25
Japan	7	5	3	83	23	31	21	40	31	7	53	24	4	11	343
Korea	0	1	0	9	1	6	2	1	7	1	6	1	0	1	36
Aust	2	0	0	1	1	0	1	2	2	0	1	1	0	0	11
Taiwan	0	0	0	2	1	1	2	2	17	0	1	0	0	0	26
UK	4	1	1	3	2	0	2	5	8	1	3	2	1	0	33
Germ	3	1	0	10	1	2	7	20	27	1	3	9	9	1	94
France	3	4	1	4	4	1	2	11	11	1	0	2	2	3	49
Italy	2	0	1	2	0	2	1	3	4	0	1	0	0	0	16
Switz	0	1	0	0	0	0	0	1	6	0	1	1	0	0	10
Neth.	1	1	0	0	2	12	0	4	12	0	4	0	0	0	36
Total (nations w/5+ pats)	72	62	37	238	76	101	76	198	326	22	127	72	31	41	1479
Total-all countries	78	64	37	242	76	93	77	207	329	22	128	72	24	41	

Q3 % (nations w/5+ pats)	Pharm	Med.Dev.	BioTech.	Comp-Rel.	Software	SemiCond.	Electronics	Chemistry	Mechanics	Acoustics	Optics	Auto-Rel	Energy-Rel	Commun-Rel
US	66.67%	77.42%	83.78%	50.84%	52.63%	45.54%	46.05%	53.03%	59.51%	50.00%	40.16%	43.06%	45.16%	60.98%
Canada	2.78%	0.00%	0.00%	1.26%	1.32%	0.00%	3.95%	2.02%	2.15%	0.00%	2.36%	1.39%	3.23%	0.00%
Japan	9.72%	8.06%	8.11%	34.87%	30.26%	30.69%	27.63%	20.20%	9.51%	31.82%	41.73%	33.33%	12.90%	26.83%
Korea	0.00%	1.61%	0.00%	3.78%	1.32%	5.94%	2.63%	0.51%	2.15%	4.55%	4.72%	1.39%	0.00%	2.44%
Aust	2.78%	0.00%	0.00%	0.42%	1.32%	0.00%	1.32%	1.01%	0.61%	0.00%	0.79%	1.39%	0.00%	0.00%
Taiwan	0.00%	0.00%	0.00%	0.84%	1.32%	0.99%	2.63%	1.01%	5.21%	0.00%	0.79%	0.00%	0.00%	0.00%
UK	5.56%	1.61%	2.70%	1.26%	2.63%	0.00%	2.63%	2.53%	2.45%	4.55%	2.36%	2.78%	3.23%	0.00%
Germ	4.17%	1.61%	0.00%	4.20%	1.32%	1.98%	9.21%	10.10%	8.28%	4.55%	2.36%	12.50%	29.03%	2.44%
France	4.17%	6.45%	2.70%	1.68%	5.26%	0.99%	2.63%	5.56%	3.37%	4.55%	0.00%	2.78%	6.45%	7.32%
Italy	2.78%	0.00%	2.70%	0.84%	0.00%	1.98%	1.32%	1.52%	1.23%	0.00%	0.79%	0.00%	0.00%	0.00%
Switz	0.00%	1.61%	0.00%	0.00%	0.00%	0.00%	0.00%	0.51%	1.84%	0.00%	0.79%	1.39%	0.00%	0.00%
Neth.	1.39%	1.61%	0.00%	0.00%	2.63%	11.88%	0.00%	2.02%	3.68%	0.00%	3.15%	0.00%	0.00%	0.00%
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

There is clearly a significant variance between countries with respect to the areas of technology in which they obtain patents. This can best be seen by comparing the percentages of any given country for any given technology with the percentage of patents that involve that technology in the population as a whole. Thus, the U.K. and Italy have more than their share of pharmaceutical patents; Japan and Korea have more than the average number of computer-related patents; Japan, France and the U.K. are over-represented in software patents; so too with Japan, Korea and Italy in semiconductors, Canada in electronics, Germany and France in chemistry, Taiwan in mechanics, Japan and Korea in optics, Germany in energy-related patents, and France in communications-related patents. Surprisingly, the U.S. has less than its share of computer-related, software, semiconductor and electronics patents, but is over-represented in the fields of pharmaceuticals, medical devices, and biotechnology.[61] This is demonstrated more clearly in Table 8.

[61] With respect to biotechnology, our study finds significantly more patents of U.S. origin than Johnson's work covering prior years. *See* Johnson, *supra* note __, at 23. This is likely because Johnson's definition of biotechnology is significantly broader than ours. He includes a number of classes that we would describe as either pharmaceutical or chemical, such as IPC A61K ("Preparations for medical, dental, or toilet purposes") and IPC G01N ("Investigating or analyzing materials by determining their chemical or physical properties"). By contrast, our definition of biotechnology, *supra* text accompanying notes 32-33 is as follows: "Any process or product involving advanced genetic techniques intended to construct new microbial or plant strains."

Table 8

Areas of Technology by U.S. Origin

Q4	US origin	non-US	Total	Q4 %	US origin	non-US	Total
Pharm	48	30	78	Pharm	61.54%	38.46%	100.00%
Med.Dev.	48	16	64	Med.Dev.	75.00%	25.00%	100.00%
BioTech.	31	6	37	BioTech.	83.78%	16.22%	100.00%
Comp-Rel.	121	121	242	Comp-Rel.	50.00%	50.00%	100.00%
Software	40	36	76	Software	52.63%	47.37%	100.00%
SemiCond.	46	47	93	SemiCond.	49.46%	50.54%	100.00%
Electronics	35	42	77	Electronics	45.45%	54.55%	100.00%
Chemistry	105	102	207	Chemistry	50.72%	49.28%	100.00%
Mechanics	194	135	329	Mechanics	58.97%	41.03%	100.00%
Acoustics	11	11	22	Acoustics	50.00%	50.00%	100.00%
Optics	51	77	128	Optics	39.84%	60.16%	100.00%
Auto-Rel	31	41	72	Auto-Rel	43.06%	56.94%	100.00%
Energy-Rel	14	10	24	Energy-Rel	58.33%	41.67%	100.00%
Commun-Rel	25	16	41	Commun-Rel	60.98%	39.02%	100.00%
Total	800	690	1490	Share of Total	54.00%	46.00%	100.00%

These relationships are strong and statistically significant.[62]

Finally, we investigated whether there was any difference in "crossover" by country. We tested this by asking whether there was any significant difference in the number of technology areas between U.S. and foreign patents, and between each country. Our test found no

---

62 We conducted a Chi-square test of homogeneity in both cases, which found significant differences in areas of technology both between foreign and U.S. patents, and country by country.

Test Result:

Foreign vs. US:

STATISTICS FOR TABLE OF ORIGIN BY TECFIELD

Statistic	DF	Value	Prob
Chi-Square	13	28.251	**0.008**

Country-by country:

STATISTICS FOR TABLE OF COUNTRY BY TECFIELD

Statistic	DF	Value	Prob
Chi-Square	143	182.774	**0.014**

statistically significant relationship between country of origin and the number of areas of technology into which any given patent fell.[63]

2. Relationships Between Technology and the Prosecution Process

We evaluated a number of relationships between areas of technology and various aspects of the patent prosecution process. For area of technology, we again used two different measures: the PTO classifications into mechanical, electrical and chemical patents, and our more detailed classification into 14 areas of technology. However, we have focused our detailed study on the latter, more detailed system. We then tested those classifications for relationships to the number of U.S. applications filed, total years the application spent in the PTO, small vs. large entity status, the number of inventors, the number and type of references cited, and number and type of claims filed.

---

[63] We used a Poisson regression.
Test Result:
Foreign vs. US:
LR Statistics For Type 1 Analysis

Source	Deviance	DF	ChiSquare	Pr>Chi
INTERCEPT	225.6527	0	.	.
ORIGIN	225.5823	1	0.0704	**0.7908**

Country-by country (with U.S. as the baseline):
LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
CA	1	0.0002	**0.9875**
JA	1	2.0446	**0.1527**
KO	1	0.0204	**0.8866**
AU	1	0.4783	**0.4892**
TW	1	2.6534	**0.1033**
UK	1	0.8047	**0.3697**
GE	1	1.3873	**0.2389**
FR	1	0.2159	**0.6422**
IT	1	0.5467	**0.4597**
SW	1	0.2865	**0.5925**
NE	1	0.0908	**0.7632**

On the Poisson regression between two variables, see *id*. at 148-150.

First, we compared the number of U.S. applications filed by a particular applicant during the prosecution process to the area of technology.[64] The results are presented in Table 9.

[64] We should emphasize that we have tested the number of times a particular application was "refiled" in whole or in part, including continuations, continuations-in-part, and divisional applications. This is not a test of what percentage of applications actually issue as patents.

Table 9

Number of Applications Filed by Area of Technology

Q43	Pharm	Med.Dev.	BioTech.	Comp-Rel.	Software	SemiCond.	Electronics	Chemistry	Mechanics	Acoustics	Optics	Auto-Rel	Energy-Rel	Commun-Rel
Total # US apps. Filed	177	98	88	357	109	131	97	390	426	27	204	82	38	54
Median	2	1	2	1	1	1	1	1	1	1	1	1	1	1
Mode	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Std. Dev.	1.66	0.94	1.55	1.00	0.81	0.76	0.57	1.36	0.72	0.61	1.10	0.39	1.14	0.65
Max	7	5	6	8	5	4	3	9	6	3	8	3	6	4
Min	1	1	1	1	1	1	1	1	0	1	1	1	1	1
Average	2.27	1.53	2.38	1.48	1.43	1.41	1.26	1.88	1.29	1.23	1.59	1.14	1.58	1.32

Q44	Mech.	Chem.	Elec.
Total # US apps. Filed	491	543	465
Median	1	1	1
Mode	1	1	1
Std. Dev.	0.75	1.33	0.85
Max	6	9	8
Min	0	1	1
Average	1.31	1.86	1.39

There is a strong relationship between area of technology and the total number of applications filed before a patent issued. The mean number of applications filed across all areas of technology was 1.50 per patent issued. Patents in the chemistry, pharmaceutical, and biotechnology fields were based on many more filings than were the norm. Indeed, pharmaceutical and biotechnology patents had on average well over two applications (that is, at least one refiling) before issuance. By contrast, patents in the electronics, mechanics, acoustics, automotive, and communications industries were significantly less likely than average to engage in refilings. These differences were statistically significant.[65]

Next, we compared the time patents spent in prosecution to the area of technology. This is a highly contested and politically divisive issue because of the change in patent term beginning in 1995.[66] Since patent terms are generally now measured from the date of first U.S. filing, spending longer in the PTO reduces the amount of protection afforded an invention. Thus,

---

[65] We used a Poisson regression.
Test Result:

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
PHARM	1	4.3942	**0.0361**
MEDDEV	1	1.6177	**0.2034**
BIOTECH	1	9.6071	**0.0019**
COMP	1	2.0218	**0.1551**
SOFTWARE	1	0.0165	**0.8979**
SEMICOND	1	0.5856	**0.4441**
ELECTRON	1	0.0202	**0.8870**
CHEMIST	1	7.7627	**0.0053**
MECHAN	1	0.2367	**0.6266**
ACOUST	1	0.9541	**0.3287**
OPTICS	1	1.8922	**0.1690**
AUTO	1	1.9188	**0.1660**
ENERGY	1	0.9790	**0.3225**
COMMUN	1	0.3090	**0.5783**

[66] For discussion of some of this controversy, as well as an earlier study of the phenomenon, see Lemley, *supra* note __, at __.

industries whose patents spend longer in prosecution than average may feel unfairly disadvantaged by the 20-year patent term.[67]

The results of this analysis are presented in Table 10.

[67] In response to these criticisms, Congress in 1999 passed the American Invention Protection Act, which includes a labrynthine series of patent term extensions to compensate inventors for various sorts of delay in the PTO.

Table 10

Time in Prosecution by Area of Technology

Q38	Pharm	Med.Dev.	BioTech.	Comp-Rel.	Software	SemiCond.	Electronics	Chemistry	Mechanics	Acoustics	Optics	Auto-Rel	Energy-Rel	Commun-Rel
Avg yrs in PTO	4.46	2.76	4.72	2.82	3.15	2.73	2.12	3.52	2.27	2.66	2.81	2.20	2.74	2.64
Median	3.24	2.33	3.91	2.42	2.78	2.33	1.86	2.59	1.97	2.11	2.39	2.08	1.87	2.52
Mode	#N/A	1.35	#N/A	1.82	1.82	1.35	1.57	1.70	1.53	2.84	2.45	2.16	3.09	2.85
Std. Dev.	2.95	1.41	2.71	1.56	1.58	1.48	0.94	2.59	1.13	1.51	1.61	0.82	1.62	1.01
Max	12.79	7.68	10.38	10.22	10.22	8.81	5.42	18.15	8.52	6.21	8.81	4.89	8.11	6.11
Min	1.02	1.01	0.71	0.82	1.07	1.10	0.67	0.93	0.73	1.04	0.82	0.76	0.94	0.94

These data demonstrate a substantial variance between the amount of time different types of patents spend in the PTO. On average, patents across all areas of technology spent 2.77 years in prosecution. Several classes of inventions did considerably better than that average, notably mechanical, electronics[68] and automotive inventions. On the other hand, patents in the areas of chemistry, pharmaceuticals, software and biotechnology took significantly longer than average to make it through the PTO.[69] In the case of both pharmaceuticals and biotechnology, the mean time in prosecution was well over four years.[70] These results are statistically significant.[71]

The policy implications of this finding are unclear. On the one hand, it seems unfair to give less protection to some types of technology than to others. Thus, these data might be used

---

68 Note that both of these classes are the more limited classes we defined, *not* the broad classes defined by the PTO classification system.

69 This confirms and updates Johnson's conclusions that patents in the biotechnology industry in particular spent longer in prosecution than other types of patents. *See* Johnson, *supra* note __, at Figures 8-10.

70 In all three cases, however, the standard deviation was significantly higher than for other classes, demonstrating greater variance in prosecution times. The higher medians here are driven in part by extremely long prosecution periods for a few patents – 18 years in one case.

71 We used a Poisson regression.
Test Result:

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
PHAM	1	12.2245	**0.0005**
MEDDEV	1	6.2988	**0.0121**
BIOTECH	1	21.5640	**0.0001**
COMP	1	2.1662	**0.1411**
SOFTWARE	1	7.8358	**0.0051**
SEMICOND	1	2.6729	**0.1021**
ELECTRON	1	1.6120	**0.2042**
CHEMIST	1	16.6183	**0.0001**
MECHAN	1	0.1658	**0.6839**
ACOUST	1	0.2909	**0.5896**
OPTICS	1	0.5685	**0.4509**
AUTO	1	0.8078	**0.3688**
ENERGY	1	2.0262	**0.1546**
COMMUN	1	0.2965	**0.5861**

The variance from the mean was statistically significant for pharmaceuticals, medical devices, biotechnology, software, and chemical inventions.

to support an argument for differential protection for certain types of technology. On the other hand, to the extent that the longer prosecution periods are within the control of patent applicants (because they result from voluntary refiling of multiple "continuation" applications),[72] the result seems much less unfair. Further, at least with respect to pharmaceutical and biotechnology inventions, it seems likely that patent protection is less important in the early stages of commercialization, and more important at the end of the patent term.[73] If so, the actual harm to owners of these patents seems less important. By contrast, the harm to owners of software patents should be correspondingly greater because of the fast-changing nature of the software field.

Next, we tested the relationship between area of technology and the size of the patent owner. For size, we have used data on the "small entity status" of the patent owner at the time of grant.[74] Thus, we have divided each area of technology into patents filed by "small entities" and "large entities" as the PTO defines them.[75] Within the small entity category, we have further subdivided patentees into three PTO categories: individuals, small businesses, and non-profit organizations. The results of these tests are reproduced in Table 11.

---

[72] On the relationship between years in the PTO and the number of applications filed, *see infra* notes __-__ and accompanying text. It is clear from Table __ that pharmaceuticals and biotechnology, two of the areas with the longest pendency times, also have a disproportionately high number of refilings.

[73] This results from the significant time such inventions normally spend in the FDA approval process.

[74] We are grateful to the PTO for providing us this data for each of the patents in our sample.

[75] For that definition, *see supra* note __.

Table 11

Entity Size By Area of Technology

Q5	Individual	Small Bus.	Non-profit	Tot. Sm. Ent.	Large Ent.	Total (Sm + Lrg.)
Pharm	11	12	1	24	54	78
Med.Dev.	16	17	2	35	29	64
BioTech.	2	6	2	10	27	37
Comp-Rel.	18	17	2	37	205	242
Software	5	3	2	10	66	76
SemiCond.	5	5	1	11	82	93
Electronics	13	9	1	23	54	77
Chemistry	20	9	2	31	176	207
Mechanics	114	59	2	175	154	329
Acoustics	5	1	0	6	16	22
Optics	10	6	2	18	110	128
Auto-Rel	7	4	0	11	61	72
Energy-Rel	2	1	1	4	20	24
Commun-Rel	6	3	0	9	32	41
Total	234	152	18	404	1086	1490

Q5 % 2.1	Individual	Small Bus	Non-profit	Tot. Sm. Ent.
Pharm	45.83%	50.00%	4.17%	100.00%
Med.Dev.	45.71%	48.57%	5.71%	100.00%
BioTech.	20.00%	60.00%	20.00%	100.00%
Comp-Rel.	48.65%	45.95%	5.41%	100.00%
Software	50.00%	30.00%	20.00%	100.00%
SemiCond.	45.45%	45.45%	9.09%	100.00%
Electronics	56.52%	39.13%	4.35%	100.00%
Chemistry	64.52%	29.03%	6.45%	100.00%
Mechanics	65.14%	33.71%	1.14%	100.00%
Acoustics	83.33%	16.67%	0.00%	100.00%
Optics	55.56%	33.33%	11.11%	100.00%
Auto-Rel	63.64%	36.36%	0.00%	100.00%
Energy-Rel	50.00%	25.00%	25.00%	100.00%
Commun-Rel	66.67%	33.33%	0.00%	100.00%

Q5 % 2.2	Tot. Sm. Ent.	Tot. Lrg. Ent.	Total
Pharm	30.77%	69.23%	100.00%
Med.Dev.	54.69%	45.31%	100.00%
BioTech.	27.03%	72.97%	100.00%
Comp-Rel.	15.29%	84.71%	100.00%
Software	13.16%	86.84%	100.00%
SemiCond.	11.83%	88.17%	100.00%
Electronics	29.87%	70.13%	100.00%
Chemistry	14.98%	85.02%	100.00%
Mechanics	53.19%	46.81%	100.00%
Acoustics	27.27%	72.73%	100.00%
Optics	14.06%	85.94%	100.00%
Auto-Rel	15.28%	84.72%	100.00%
Energy-Rel	16.67%	83.33%	100.00%
Commun-Rel	21.95%	78.05%	100.00%

On average, 29.3% of the patents in our sample were filed by small entities, and 70.7% by large entities. The small entity numbers are a composite of three sub-categories: individuals, who filed 17.5% of all the patents in the sample, non-profits, who filed 1.1%, and small businesses, who filed 10.7%. The data in Table 11 demonstrate a major difference in the size of the patentee by area of technology. Small entities patented more than half of the medical devices and mechanical inventions in our sample. By contrast, they patented less than 1/3 of every other type of invention, and in many categories (computer-related, software, semiconductors, chemistry, optics, automotive, and energy-related) small entities obtained less than 20% of the patents in this field. These results are statistically significant, both between large and small entities and across the range of each type of entity.[76]

In some of these fields, the results are not terribly surprising: mechanical and medical devices are easier for individuals to build than semiconductor chips, for example. Many of the areas of technology dominated by large entities are capital intensive or dominated by large

[76] We conducted a Chi-square test of homogeneity between areas of technology and each category.
Test Result:
Small vs. Large

STATISTICS FOR TABLE OF ENTISIZE BY TECFIELD

Statistic	DF	Value	Prob
Chi-Square	13	165.960	**0.001**

By each category (WARNING: 46% of the cells have expected counts less than 5. Chi-Square may not be a valid test.)

STATISTICS FOR TABLE OF ENTICATE BY TECFIELD

Statistic	DF	Value	Prob
Chi-Square	39	194.743	**0.001**

We caution, however, that the test of each category may not be valid for some categories, notably non-profits, because of the small sample size in those categories.

companies; semiconductors and automotive inventions are two obvious examples. But it is somewhat more surprising that software and computer-related inventions, which generally are not thought to require a large capital investment, are nonetheless patented overwhelmingly by large entities. And the results certainly suggest that the importance of small inventors in statistical terms depends greatly on the area of technology in question.[77]

A related issue is the relationship between area of technology and the number of inventors listed on any given patent.[78] We found only modest differences between the mean number of inventors in each area of technology. The data are presented in Table 12.

---

[77] It is of course possible that inventions by individuals or small businesses are somehow more important in qualitative terms than those made by large entities. We have no data to test such an hypothesis, and we express no opinion on the question here.

[78] This is related because it is reasonable to expect that patents acquired by large entities will list more co-inventors than patents by individuals or small businesses. We test this hypothesis *infra* notes __-__ and accompanying text.

Table 12

Number of Inventors by Area of Technology

Q6	Pharm	Med.Dev	BioTech.	Comp-Rel.	Software	SemiCond.	Electronics	Chemistry	Mechanics	Acoustics	Optics	Auto-Rel	Energy-Rel	Commun-Rel
Avg # Inventors	2.81	2.33	2.84	2.28	2.42	2.13	2.48	2.85	1.77	1.86	2.57	2.07	2.79	2.27
Median	2	2	2	2	2	2	2	2	1	2	2	2	2	2
Mode	2	1	2	1	2	1	2	2	1	1	1	1	1	1
Std. Dev.	1.73	1.72	1.91	1.49	1.55	1.35	1.66	1.71	1.18	0.99	1.76	1.29	2.08	1.38
Max	9	10	11	10	10	7	10	10	9	4	10	7	9	7
Min	1	1	1	1	1	1	1	1	1	1	1	1	1	1

On average, patents in our sample had 2.25 inventors. Pharmaceutical, biotechnology, and chemical inventions had somewhat more inventors on each patent (more than 2.8 each on average). By contrast, mechanical and acoustical inventions had less than 1.9 inventors each on average. The median patent in each class except mechanics had 2 named inventors. These differences are statistically significant,[79] and they track to some extent the size differentials just noted – areas of technology which are mainly the province of large companies also tend to have more inventors per patent, while areas frequently patented by small entities are more likely to have single inventors. But the ranges are roughly the same across all areas of technology, and the differences between categories aren't all that great.

We also tested the relationship between areas of technology and the number and type of prior art references cited in the patent. The results are presented in Table 13.

[79] We used a Poisson regression.
Test Result:

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
PHAM	1	0.0172	**0.8957**
MEDDEV	1	5.7306	**0.0167**
BIOTECH	1	3.1215	**0.0773**
COMP	1	0.3648	**0.5458**
SOFTWARE	1	1.6939	**0.1931**
SEMICOND	1	0.4749	**0.4907**
ELECTRON	1	0.2155	**0.6425**
CHEMIST	1	5.3870	**0.0203**
MECHAN	1	5.6279	**0.0177**
ACOUST	1	2.6955	**0.1006**
OPTICS	1	3.6942	**0.0546**
AUTO	1	0.5717	**0.4496**
ENERGY	1	4.1933	**0.0406**
COMMUN	1	0.1105	**0.7396**

Table 13

Prior Art References By Area of Technology

U.S. Patent References

Q10	Pharm	Med.Dev.	BioTech.	Comp-Rel.	Software	SemiCond.	Electronics	Chemistry	Mechanics	Acoustics	Optics	Auto-Rel	Energy-Rel	Commun-Rel
Avg # US pat ref	6.06	19.44	4.59	10.21	9.59	6.49	9.35	9.94	12.70	8.95	10.16	12.36	14.63	10.56
Median	3	12	2	7	7	5	7	6	8	7	7	8	10	6
Mode	0	5	0	6	5	2	4	3	6	4	5	7	10	6
Std. Dev.	10.14	22.60	7.40	11.43	12.90	5.20	11.32	12.44	14.33	5.98	14.19	13.88	16.94	14.50
Max	76	137	38	112	112	25	87	82	137	19	137	68	82	87
Min	0	0	0	0	1	0	0	0	0	1	0	0	1	1

Foreign Patent References

Q14	Pharm	Med.Dev.	BioTech.	Comp-Rel.	Software	SemiCond.	Electronics	Chemistry	Mechanics	Acoustics	Optics	Auto-Rel	Energy-Rel	Commun-Rel
Avg # For pat ref	2.60	2.84	2.97	1.77	1.26	1.57	1.66	3.63	2.60	1.82	2.14	3.83	1.79	1.66
Median	1	1	1	0	0	1	0	2	1	0	1	2	2	0
Mode	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Std. Dev.	3.84	5.80	7.36	2.72	2.39	2.17	2.93	4.62	4.21	3.53	3.09	4.83	1.98	3.40
Max	24	36	43	16	12	10	18	24	36	15	17	19	6	18
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Non-patent References

Q18	Pharm	Med.Dev.	BioTech.	Comp-Rel.	Software	SemiCond.	Electronics	Chemistry	Mechanics	Acoustics	Optics	Auto-Rel	Energy-Rel	Commun-Rel
Avg # non-pat ref	9.88	3.56	16.30	2.75	3.54	1.34	0.83	3.43	0.53	2.45	2.72	0.63	0.75	2.41
Median	5	0	15	0	1	0	0	1	0	0	0	0	0	0
Mode	0	0	7	0	0	0	0	0	0	0	0	0	0	0
Std. Dev.	12.60	10.55	12.68	7.56	7.33	3.03	2.32	6.92	1.83	6.35	7.43	1.64	1.15	9.84
Max	68	67	68	63	36	19	14	55	19	30	67	8	3	63
Min	0	0	1	0	0	0	0	0	0	0	0	0	0	0

Total Prior Art References

Q22	Pharm	Med.Dev.	BioTech.	Comp-Rel.	Software	SemiCond.	Electronics	Chemistry	Mechanics	Acoustics	Optics	Auto-Rel	Energy-Rel	Commun-Rel
Avg # total pat ref	18.55	25.84	23.86	14.74	14.39	9.41	11.84	17.00	15.84	13.23	15.02	16.82	17.17	14.63
Median	12	15	17	10	10	8	9	11	11	10	10	10	14	8
Mode	1	11	8	7	7	5	4	8	5	19	7	7	25	6
Std. Dev.	18.34	29.86	20.19	17.14	17.15	6.59	13.75	17.11	16.75	11.72	18.53	16.50	17.76	23.05
Max	83	163	93	137	137	30	105	101	163	58	163	84	87	118
Min	1	1	1	1	1	1	0	1	0	1	1	1	1	1

There are a number of interesting facts in this data. On average, patents across all ranges of technology cited 15.16 references. The differences between different technology areas were dramatic, however.[80] Semiconductor and electronics patents cited many fewer references than average (9.41 and 11.84 respectively). On the other extreme, medical devices cited 25.84 references on average, and biotechnology patents cited a mean of 23.86 references.[81] These differences are also reflected in the median number of references cited (8 for semiconductors and 9 for electronics patents, compared with 15 for medical devices and 17 for biotechnology). Finally, it is interesting to note that at least some patents in the electronics and mechanical fields cited *no* prior art references whatsoever.

There were also significant differences in the citation patterns for different types of prior art. Citation of U.S. patents as prior art references ranged from a low of 4.59 on average for biotechnology patents and 6.06 on average for pharmaceutical patents to a high of 19.44 for

---

[80] These differences are statistically significant. We used a Poisson regression to relate area of technology to number of references cited.

Test Result:

Total references

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
PHAM	1	0.1179	**0.7314**
MEDDEV	1	501.1434	**0.0001**
BIOTECH	1	179.9105	**0.0001**
COMP	1	5.6777	**0.0172**
SOFTWARE	1	3.3909	**0.0656**
SEMICOND	1	23.5891	**0.0001**
ELECTRON	1	2.5345	**0.1114**
CHEMIST	1	84.6291	**0.0001**
MECHAN	1	17.9960	**0.0001**
ACOUST	1	1.8188	**0.1775**
OPTICS	1	28.2701	**0.0001**
AUTO	1	70.1559	**0.0001**
ENERGY	1	33.4952	**0.0001**
COMMUN	1	8.7345	**0.0031**

[81] Again, despite definitional differences, our findings regarding biotechnology are consistent with Johnson's findings for earlier time periods that biotechnology patents cite significantly more references than other sorts of patents. Johnson, *supra* note __, at Figure 12.

medical device patents.[82] By contrast, the citation patterns are totally different for foreign patent references. There, software and semiconductor inventions cite the fewest foreign patents (1.26 and 1.57 on average respectively), while chemistry and automotive patents cite the most foreign patents (3.63 and 3.83 respectively). In many areas, including computer-related patents, software, electronics, and acoustics, the median patent did not cite *any* foreign patent references.

Finally, the variance was most dramatic in the non-patent references cited in each area of technology. Biotechnology and pharmaceutical patents cited the most non-patent art, citing 16.30 and 9.88 references respectively on average. The median biotechnology patent cited 15 non-patent references, and the median pharmaceutical patent cited 5 such references. On the other hand, in many areas of technology patentees cited little or no non-patent prior art. For example, the median patent cited *no* non-patent prior art in each of the following fields: medical devices, computer-related, semiconductor, electronics, mechanics, acoustics, optics, automotive, energy, and communications. Put another way, in only four of the 14 areas of technology did more than half of the patents cite any non-patent art whatsoever. Interestingly, despite vocal criticism from some quarters,[83] the software industry actually cited relatively more non-patent prior art than in most other areas of technology.

Finally, we tested the relationship between the number and type of claims filed and the area of technology. The number of claims filed is directly related to the cost of prosecution, and can serve as a proxy either the complexity of the subject matter or the importance of the patent to the applicant. The results are presented in Table 14.

---

[82] These differences were also reflected in the median numbers: the median biotechnology patent cited 2 U.S. patent references, the median pharmaceutical patent cited 3 U.S. patent references, while the median medical device patent cited 12 U.S. patent references.

[83] *See* Ahronian, *supra* note __.

Table 14

Number of Claims by Area of Technology

Total Claims

Q26	Pharm	Med.Dev.	BioTech.	Comp-Rel.	Software	SemiCond.	Electronics	Chemistry	Mechanics	Acoustics	Optics	Auto-Rel	Energy-Rel	Commun-Rel
Avg # total claims	14.99	17.05	13.30	16.02	17.11	15.83	15.47	15.19	13.36	18.64	16.13	14.89	15.63	16.24
Median	11	13	9	12	11	13	13	14	11	17	14	13	13	12
Mode	8	27	7	3	9	6	10	15	10	16	20	10	10	9
Std. Dev.	13.22	12.61	9.42	13.83	18.43	11.93	12.22	10.67	9.45	9.52	14.21	10.04	9.25	12.91
Max	82	61	36	120	120	64	57	82	55	43	120	55	40	49
Min	1	1	3	1	1	1	1	1	1	6	1	2	3	1

Independent Claims

Q30	Pharm	Med.Dev.	BioTech.	Comp-Rel.	Software	SemiCond.	Electronics	Chemistry	Mechanics	Acoustics	Optics	Auto-Rel	Energy-Rel	Commun-Rel
Avg # ind claims	2.86	3.31	3.30	3.27	3.53	3.03	2.56	2.22	2.56	3.59	2.95	2.75	3.88	3.44
Median	2	3	3	3	3	3	2	2	2	4	2	3	3	2
Mode	1	3	2	1	2	1	1	1	1	1	2	3	3	2
Std. Dev.	2.20	3.08	2.36	2.54	2.75	2.21	1.59	1.63	2.30	2.28	2.15	1.63	4.79	2.94
Max	11	17	10	17	16	11	8	11	24	10	16	8	24	14
Min	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Dependent Claims

Q34	Pharm	Med.Dev.	BioTech.	Comp-Rel.	Software	SemiCond.	Electronics	Chemistry	Mechanics	Acoustics	Optics	Auto-Rel	Energy-Rel	Commun-Rel
Avg # dep claims	12.13	13.73	10.00	12.75	13.58	12.80	12.91	12.97	10.80	15.05	13.18	12.13	11.75	12.80
Median	8	12	6	10	9	10	10	11	9	15	11	11	10	9
Mode	7	8	4	2	10	8	2	14	7	16	2	2	12	5
Std. Dev.	12.75	10.81	8.76	12.49	17.11	10.86	11.50	10.19	8.43	8.07	13.50	9.45	9.01	10.77
Max	80	44	34	115	115	55	51	80	47	33	115	47	37	38
Min	0	0	0	0	0	0	0	0	0	2	0	0	2	0

The average number of claims across all areas of technology is 14.87 total claims, 2.75 independent claims and 12.12 dependent claims. The data show some variance in total claims (from a low of 13.30 on average for biotechnology patents to a high of 18.64 for acoustics patents; the median varies from a low of 9 for biotechnology to a high of 17 for acoustics), but the variance is not particularly great.[84] The pattern is similar for both independent and dependent claims.

3. Relationships Between Country of Origin and the Prosecution Process

Just as in section 2 we related area of technology to a number of specific facts about the prosecution process, in this section we test the relationship between the same prosecution process metrics and the country of the invention's origin. Thus, we test the relationship between country of origin and the following factors: number of applications filed, time spent in prosecution, small entity status, number of inventors, number and type of references cited, and number and type of claims filed.

---

[84] It is, however, statistically significant. We used a Poisson regression.
Test Result:
Total claims

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
PHAM	1	1.2274	**0.2679**
MEDDEV	1	40.8937	**0.0001**
BIOTECH	1	8.0129	**0.0046**
COMP	1	1.1876	**0.2758**
SOFTWARE	1	10.5704	**0.0011**
SEMICOND	1	0.0726	**0.7875**
ELECTRON	1	0.3770	**0.5392**
CHEMIST	1	0.7676	**0.3810**
MECHAN	1	18.1854	**0.0001**
ACOUST	1	9.5832	**0.0020**
OPTICS	1	1.3676	**0.2422**
AUTO	1	4.9334	**0.0263**
ENERGY	1	1.6981	**0.1925**
COMMUN	1	1.0130	**0.3142**

First, we tested the relationship between nationality of origin and the total number of U.S. applications filed leading up to the issuance of each patent. As noted above, abandoning and refiling applications is a legal but controversial process, because it has been associated with so-called "submarine patents."[85] Here we evaluate whether use of this practice differs by nationality. We tested two sets of data: U.S. vs. foreign patents, and a country-by-country analysis for each of the 12 countries with five or more patents in the sample. The results are presented in Table 15.

---

[85] *See, e.g.,* Steve Blount & Louis Zarfas, *The Use of Delaying Tactics to Obtain Submarine Patents and Amend Around a Patent That a Competitor Has Designed Around,* 81 **J. Pat. & Trademark Ofc. Soc'y** 11 (1999); Timothy R. DeWitt, *Does Supreme Court Precedent Sink Submarine Patents,* 38 **Idea** 601 (1998); Lemley, *supra* note __, at __; David L. Marcus, *Is the Submarine Patent Torpedoed? Ford Motor Co. v. Lemelson and the Revival of Continuation Application Laches,* 70 **Temple L. Rev.** 521 (1997); James W. Morando & Christian H. Nadan, *Silent Enemies*, **Recorder**, May 4, 1994, at 10.

Table 15

Number of Applications Filed by Country of Origin

Q46	US	Canada	Japan	Korea	Australia	Taiwan	UK	Germ.	France	Italy	Switz.	Neth.
Total # US apps. Filed	865	27	317	32	7	24	29	76	47	18	8	16
Median	1	1	1	1	1	1	1	1	1	1	1	1
Mode	1	1	1	1	1	1	1	1	1	1	1	1
Std. Dev.	1.12	1.18	0.95	0.54	0.41	0	1.02	0.53	1.03	0.96	0	0.89
Max	9	5	8	3	2	1	5	4	5	4	1	4
Min	1	1	1	1	1	1	1	0	1	1	1	1
Mean	1.60	1.59	1.50	1.28	1.17	1.00	1.53	1.15	1.52	1.38	1.00	1.33

The data show substantial variance by country in the use of the abandonment and refiling procedure.[86] While this procedure was used only by a minority of patentees in every country tested, the U.S. had more abandonments and refilings on average than any other country represented in the sample. Other countries with refiling rates nearly as high include Canada, Japan, the U.K. and France. By contrast, other countries had significantly lower refiling rates. Indeed, two countries – Taiwan and Switzerland – *never* engaged in refiling in the sampled patents.

Next, we related country of origin to the time spent in prosecution. As with other tests in this section, we tested both U.S. vs. foreign patents, and country-by-country results. The results are presented in Table 16.

[86] These results are statistically significant. We used a Poisson regression.
Test Result:

Foreign vs. US

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ORIGIN	1	8.3247	**0.0039**

Country vs. country (with the U.S. as the baseline)

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
CA	1	0.0022	**0.9623**
JA	1	1.1335	**0.2870**
KO	1	1.6763	**0.1954**
AU	1	0.7799	**0.3772**
TW	1	6.0600	**0.0138**
UK	1	0.0684	**0.7937**
GE	1	8.1832	**0.0042**
FR	1	0.1406	**0.7077**
IT	1	0.3964	**0.5289**
SW	1	2.0712	**0.1501**
NE	1	0.5658	**0.4519**

Table 16

Time Spent in Prosecution by Country of Origin

Q39	US	Canada	Japan	Korea	Australia	Taiwan	UK	Germ.	France	Italy	Switz.	Neth.
Avg yrs in PTO	2.92	2.98	2.76	2.29	3.57	1.32	3.50	2.37	2.65	2.71	1.83	2.40
Median	2.33	2.10	2.37	2.13	1.95	1.30	2.37	2.15	2.32	2.12	1.94	1.86
Mode	1.35	#N/A	1.46	#N/A	#N/A	1.27	#N/A	1.63	2.85	#N/A	1.95	#N/A
Std. Dev.	1.99	2.16	1.45	0.93	4.00	0.35	2.82	1.36	1.32	1.54	0.53	1.74
Max	18.15	9.70	8.96	4.77	11.67	2.19	12.79	10.22	6.20	6.45	2.54	7.34
Min	0.69	1.51	0.94	1.13	1.47	0.67	1.28	0.82	1.01	1.22	1.18	1.03

Q40	US	Non-US
Avg yrs in PTO	2.92	2.60
Median	2.33	2.17
Mode	1.35	1.82
Std. Dev.	1.99	1.56
Max	18.15	12.79
Min	0.69	0.67

The results are quite interesting. U.S. patents spent significantly longer in prosecution than foreign patents (2.92 years for U.S. patents, compared with 2.60 years for foreign patents). The variance among individual countries is even greater, ranging from a low of 1.32 years on average for Taiwanese patents to a high of 3.57 years for Australian patents.[87] We encourage caution in attempting to explain these results, however. As noted in the previous section, time spent in prosecution may in turn be dependent on other factors (like the total number of applications filed). Thus, the fact that the U.S. refiled patent applications more often than any other country likely contributes to its high time in prosecution, and Taiwanese reluctance to engage in the practice to their quicker prosecution times. Further, because different countries obtain patents in different areas of technology, the national variance may be related to the variance by area of

87 These results are statistically significant. We used a Gamma regression because one of the variables is continuous rather than discrete. [cite re Gamma regression and check explanation].

Test Result:

Foreign vs. US

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ORIGIN	1	11.8374	**0.0006**

Country-by-country (with the U.S. as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
CA	1	0.0222	**0.8816**
JA	1	1.9377	**0.1639**
KO	1	4.8013	**0.0284**
AU	1	0.9258	**0.3360**
TW	1	41.3841	**0.0001**
UK	1	2.2880	**0.1304**
GE	1	8.5161	**0.0035**
FR	1	1.0154	**0.3136**
IT	1	0.2705	**0.6030**
SW	1	5.5456	**0.0185**
NE	1	1.5527	**0.2127**

However, the results of the country-by-country analysis are less certain, because with some countries the size of the sample was so small. Thus Australia, the outlier in this test, had only six patents in the sample, and this may reduce the predictive power of the results for that country. Indeed, the median patent for Australia spent less than two years in prosecution, well below the median for many other countries with lower means.

technology observed earlier.[88] Thus, the fact that the U.S. has disproportionately more biotechnology and pharmaceutical patents, coupled with the fact that those patents tend to spend longer in prosecution, may help to explain why U.S. patents spend longer in prosecution on average. Again, however, settling on an explanation is not possible from this data alone.

Next, we examined how small entity status varied by nationality. The results are presented in Table 17.

Table 17

Small Entity Status by Country of Origin

Q47	Small Entities	% of National Total
US	217	40.19%
Canada	10	58.82%
Japan	7	3.30%
Korea	3	12.00%
Australia	4	66.67%
Taiwan	20	83.33%
UK	5	26.32%
Germ.	5	7.58%
France	4	12.90%
Italy	4	30.77%
Switz.	5	62.50%
Neth.	2	16.67%

The results are striking. There is tremendous variance by country in whether small entities obtain a significant portion of the patents in the sample.[89] U.S. patentees are more likely than

---

88 *See supra* notes __-__ and accompanying text.

89 The results are statistically significant, though the country-by-country results must be interpreted with caution. We used a Chi-square test of homogeneity.
Test Result:

Foreign vs. US
STATISTICS FOR TABLE OF ORIGIN BY ENTICATE

Statistic	DF	Value	Prob
Chi-Square	3	71.664	**0.001**

Country-by-country (WARNING: 60% of the cells have expected counts less than 5. Chi-Square may not be a valid test.)

foreign patentees to be small entities. Patentees in Taiwan, Australia, Switzerland and Canada are more likely than average to be small entities; patentees in Japan, Korea, Germany and France are unlikely to be small entities. What is even more notable is the magnitude of the differences. Compare the two largest patentees: the U.S. and Japan. 40.19% of U.S. patents in the sample were obtained by small entities, compared with only 3.3% of Japanese patents.

Next, we related nationality of origin to the number of inventors on each patent. The results are presented in Table 18.

STATISTICS FOR TABLE OF COUNTRY BY ENTICATE

Statistic	DF	Value	Prob
Chi-Square	33	227.327	**0.001**

Table 18

Number of Inventors by Country of Origin

Q7	US	Canada	Japan	Korea	Australia	Taiwan	UK	Germ.	France	Italy	Switz.	Neth.
Avg # Inventors	2.14	1.47	2.75	1.48	1.00	1.42	2.26	2.45	2.48	2.08	2.25	2.17
Median	2	1	2	1	1	1	2	2	2	1	2	2
Mode	1	1	1	1	1	1	1	1	2	1	2	2
Std. Dev.	1.36	0.62	1.84	0.77	0.00	0.65	2.05	1.59	2.01	1.38	1.98	1.27
Max	10	3	10	4	1	3	10	8	11	5	7	5
Min	1	1	1	1	1	1	1	1	1	1	1	1

Q8	US	Non-US
Avg # Inventors	2.14	2.38
Median	2	2
Mode	1	1
Std. Dev.	1.36	1.69
Max	10	11
Min	1	1

The results do not show major differences by country. While there is variance within each country, especially for countries like Australia with small sample sizes, the variance by country is not statistically significant.[90] There is a statistically significant difference between the number of inventors on U.S. and foreign patents, though it is fairly modest – U.S. patents have 2.14 inventors on average, and foreign patents have 2.38 on average. Both, however, have a median of two inventors, and a maximum of 10 or 11 inventors.

We tested the relationship between nationality of origin and the number and type of prior art references cited. The results are presented in Tables 19 and 20.

[90] We used a Poisson regression. The difference between U.S. and foreign patents as a whole was statistically significant, but the country-by-country data was not.

Test Result:

Foreign vs. US

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ORIGIN	1	6.3635	**0.0116**

Country-by-country (with the U.S. as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
CA	1	3.9426	**0.0471**
JA	1	23.2583	**0.0001**
KO	1	5.5550	**0.0184**
AU	1	4.5400	**0.0331**
TW	1	6.4926	**0.0108**
UK	1	0.1178	**0.7314**
GE	1	2.5769	**0.1084**
FR	1	1.4912	**0.2220**
IT	1	0.0275	**0.8683**
SW	1	0.0401	**0.8413**
NE	1	0.0026	**0.9591**

Table 19

Number and Type of Prior Art References by Country of Origin

U.S. Patent References

Q11	US	Canada	Japan	Korea	Australia	Taiwan	UK	Germ.	France	Italy	Switz.	Neth.
Avg # US pat ref	13.85	9.82	6.09	5.68	3.83	5.63	6.21	6.21	5.48	5.00	5.50	6.17
Median	9	7	5	5	5	6	5	6	5	4	5	5
Mode	7	5	4	3	5	6	1	6	2	4	2	5
Std. Dev.	15.21	8.42	4.27	3.66	1.94	3.21	5.45	5.39	4.03	3.74	3.55	4.09
Max	137	29	29	14	6	13	18	37	15	14	12	15
Min	0	0	0	1	1	0	0	0	0	0	2	1

Foreign Patent References

Q15	US	Canada	Japan	Korea	Australia	Taiwan	UK	Germ.	France	Italy	Switz.	Neth.
Avg # For pat ref	2.03	1.76	3.03	0.52	3.83	0.33	4.95	4.33	2.94	2.54	2.88	2.92
Median	0	0	2	0	2	0	4	4	2	2	3	3
Mode	0	0	0	0	1	0	0	4	0	0	2	3
Std. Dev.	4.24	3.19	3.46	0.82	4.17	0.76	5.73	4.45	3.00	2.50	2.42	2.57
Max	43	11	18	3	10	3	24	26	12	7	7	7
Min	0	0	0	0	0	0	0	0	0	0	0	0

Non-Patent References

Q19	US	Canada	Japan	Korea	Australia	Taiwan	UK	Germ.	France	Italy	Switz.	Neth.
Avg # non-pat ref	3.41	0.65	1.16	0.20	9.17	0.13	2.79	0.79	1.06	1.38	0.63	1.67
Median	0	0	0	0	0	0	0	0	0	1	0	1
Mode	0	0	0	0	0	0	0	0	0	0	0	0
Std. Dev.	8.19	1.11	2.50	1.00	22.45	0.34	5.84	1.40	2.22	1.80	1.06	3.39
Max	68	4	19	5	55	1	19	8	10	5	3	12
Min	0	0	0	0	0	0	0	0	0	0	0	0

Total Prior Art References

Q23	US	Canada	Japan	Korea	Australia	Taiwan	UK	Germ.	France	Italy	Switz.	Neth.
Avg # total pat ref	19.29	12.24	10.28	6.40	16.83	6.08	13.95	11.33	9.48	8.92	9.00	10.75
Median	13	7	9	5	6	6	12	10	9	7	7	9
Mode	7	2	7	5	6	5	1	10	14	7	6	8
Std. Dev.	20.07	11.24	6.58	4.04	26.09	3.51	12.31	8.59	5.03	5.01	4.34	7.89
Max	163	37	47	15	70	16	49	64	22	20	16	30
Min	0	1	1	1	5	2	1	1	1	4	5	2

Table 20

Number and Type of Prior Art References by Country of Origin

Q12	US	Non-US	Q16	US	Non-US
Avg # US pat ref	13.85	6.23	Avg # For pat ref	2.03	2.93
Median	9	5	Median	0	2
Mode	7	5	Mode	0	0
Std. Dev.	15.21	4.86	Std. Dev.	4.24	3.58
Max	137	37	Max	43	26
Min	0	0	Min	0	0

Q20	US	Non-US	Q24	US	Non-US
Avg # non-pat ref	3.41	1.16	Avg # total pat ref	19.29	10.31
Median	0	0	Median	13	9
Mode	0	0	Mode	7	7
Std. Dev.	8.19	3.49	Std. Dev.	20.07	7.82
Max	68	55	Max	163	70
Min	0	0	Min	0	1

There are a number of interesting relationships among these data. U.S. patents included significantly more prior art references than their foreign counterparts, both on average (19.29 per U.S. patent vs. 10.31 per foreign patent) and at the median (13 in the median U.S. patent vs. 9 in the median foreign patent). As might be expected, the breakdown of this prior art reflects national origin to some extent: foreign patentees are more likely to cite foreign patents as prior art, and much less likely to cite U.S. patents.

Finally, we investigated the relationship between nationality of origin and the number and type of claims in each of the patents. The results are presented in Tables 21 and 22.

Table 21
Number and Type of Claims by Country of Origin

<u>Independent Claims</u>

Q31	US	Canada	Japan	Korea	Australia	Taiwan	UK	Germ.	France	Italy	Switz.	Neth.
Avg # ind claims	2.95	2.53	2.93	2.88	4.17	1.21	2.21	1.98	2.23	2.23	1.38	2.25
Median	2	3	2	2	3	1	2	2	2	2	1	2
Mode	1	3	1	2	3	1	1	1	1	1	1	1
Std. Dev.	2.31	1.12	2.44	2.52	3.43	0.66	1.32	1.41	1.56	1.54	0.74	1.71
Max	24	4	16	11	11	4	5	7	7	5	3	6
Min	1	1	1	1	2	1	1	1	1	1	1	1

<u>Dependent Claims</u>

Q35	US	Canada	Japan	Korea	Australia	Taiwan	UK	Germ.	France	Italy	Switz.	Neth.
Avg # dep claims	13.82	13.76	9.91	7.60	11.67	2.83	12.05	10.09	12.06	11.69	12.63	13.75
Median	12	12	8	5	13	2	12	9	11	8	11	13
Mode	5	8	4	3	11	0	17	7	0	4	#N/A	18
Std. Dev.	11.66	8.87	9.23	8.84	6.44	2.96	5.89	6.93	8.37	11.14	10.03	8.32
Max	115	38	51	44	19	11	26	29	34	45	26	28
Min	0	0	0	0	0	0	2	0	0	4	0	1

<u>Total Claims</u>

Q27	US	Canada	Japan	Korea	Australia	Taiwan	UK	Germ.	France	Italy	Switz.	Neth.
Avg # total claims	16.78	16.29	12.83	10.48	15.83	4.04	14.26	12.09	14.29	13.92	14.00	16.00
Median	14	14	10	8	17	3	14	11	13	10	12	15
Mode	20	10	6	4	17	2	19	14	10	10	#N/A	#N/A
Std. Dev.	12.65	8.84	10.41	10.48	7.28	2.96	6.45	7.40	8.31	11.84	10.36	9.14
Max	120	41	57	52	23	12	30	35	37	50	29	32
Min	1	1	1	2	3	1	3	2	1	5	1	4

Table 22

Number and Type of Claims by Country of Origin

Q32	US	Non-US	Q36	US	Non-US	Q28	US	Non-US
Avg # ind claims	2.95	2.52	Avg # dep claims	13.82	10.12	Avg # total claims	16.78	12.64
Median	2	2	Median	12	8	Median	14	10
Mode	1	1	Mode	5	2	Mode	20	10
Std. Dev.	2.31	2.08	Std. Dev.	11.66	8.56	Std. Dev.	12.65	9.43
Max	24	16	Max	115	51	Max	120	57
Min	1	1	Min	0	0	Min	1	1

U.S. patents had more claims on average than foreign patents. This is true for both independent and dependent claims, but the difference is more pronounced for the latter. The U.S. had an average of 16.78 total claims, and the median U.S. patent had 14 claims. By contrast, foreign patents had an average of 12.64 claims, and the median foreign patent had only 10 claims. Further, at least one U.S. patent had as many as 120 claims, more than twice the maximum number of claims in a foreign patent.

The differences also carry over to a country-by-country analysis. The U.S. had more claims on average than any other country, though both Canada and the Netherlands were close (and the median Dutch patent had more claims than the median U.S. patent). The variance among other countries is not terribly striking, with one exception. Taiwanese patents had far fewer claims than patents from any other country. The differences between U.S. and foreign patents, and between each country, are statistically significant.[91]

---

[91] We used a Poisson regression.
Test Result:
Total Claims –

US vs. Foreign

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ORIGIN	1	290.7071	**0.0001**

Country-by-country (with the U.S. as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
CA	1	0.2496	**0.6173**
JA	1	158.5613	**0.0001**
KO	1	65.9956	**0.0001**
AU	1	0.3339	**0.5634**
TW	1	325.8377	**0.0001**
UK	1	7.4042	**0.0065**
GE	1	82.1215	**0.0001**
FR	1	11.5788	**0.0007**
IT	1	6.6363	**0.0100**
SW	1	3.8946	**0.0484**
NE	1	0.4501	**0.5023**

Independent Claims –

US vs. Foreign

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ORIGIN	1	17.7774	**0.0001**

Country-by-country (with the U.S. as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
CA	1	1.0752	**0.2998**
JA	1	0.0407	**0.8400**
KO	1	0.0488	**0.8252**
AU	1	2.5968	**0.1071**
TW	1	30.9719	**0.0001**
UK	1	3.8074	**0.0510**
GE	1	20.5631	**0.0001**
FR	1	5.8329	**0.0157**
IT	1	2.4833	**0.1151**
SW	1	8.3696	**0.0038**
NE	1	2.1704	**0.1407**

Dependent Claims –

US vs. Foreign

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ORIGIN	1	285.4291	**0.0001**

4. Relationships Among Prosecution Factors

Finally, we tested a number of relationships among what we refer to as "prosecution-related factors" – that is, evidence about the prosecution process itself, rather than the nationality of the patentee or the area of technology. In this section, we describe relationships among the number of U.S. applications filed, the time spent in prosecution, small entity status, the number of inventors, the number and type of prior art references cited, and the number and type of claims filed.

a. Relationships Based on Number of Applications Filed

First, we tested the relationship between small entity status and the number of applications filed. The results are presented in Table 23.

Table 23
Number of Applications Filed by Small Entity Status

Q48	Sm. Ent.
Total # US apps. Filed	426
Median	1
Mode	1
Std. Dev.	1.02
Max	9
Min	1
Mean	1.45

Country-by-country (with the U.S. as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
CA	1	0.0065	**0.9357**
JA	1	194.5164	**0.0001**
KO	1	81.0531	**0.0001**
AU	1	2.1390	**0.1436**
TW	1	303.4983	**0.0001**
UK	1	4.4315	**0.0353**
GE	1	62.8443	**0.0001**
FR	1	6.9883	**0.0082**
IT	1	4.4682	**0.0345**
SW	1	0.8650	**0.3523**
NE	1	0.0067	**0.9349**

We found no significant relationship between entity size and the number of applications filed.[92]

We also conducted statistical tests of the relationship between the total number of applications filed and the time spent in prosecution, and the relationship between the total number of applications filed and the number of prior art references cited. We found a significant relationship in both cases: refiling more times increased the time spent in prosecution[93] and increased the number of references of all types cited in the patent.[94] Because these tests compare two continuous variables, we have not represented the data in tabular form.

---

92 We used a Poisson regression.
Test Result:

Small vs. Large

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ENTISIZE	1	0.5651	**0.4522**

By each category within small entities (with individual as the baseline)

Source	DF	ChiSquare	Pr>Chi
NPROFIT	1	0.1527	**0.6960**
SBIZ	1	0.4854	**0.4860**
LBIZ	1	0.0953	**0.7576**

93 We used a Poisson regression.
Test Result:

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
YPTO	1	295.3397	**0.0001**

94 We used a Poisson regression.
Test Result:

Total references

LR Statistics For Type 3 Analysis

Source DF ChiSquare Pr>Chi

Related to the test of total applications filed against time spent in prosecution is the question of how individual sorts of refilings affect time spent in prosecution. We divided patents into different categories depending on whether they file a continuing application or a CIP, a divisional, or no prior U.S. filing at all. We also tested the effects of claiming foreign priority on U.S. prosecution time. The results are presented in Table 24.

Table 24

Time in Prosecution by Nature of Prior Application Filed

Q42	Priority Based on Instant Application	Priority Based on Continuation	Priority Based on Divisional	Priority Based on CIP	Priority Based on Foreign Filing
Avg yrs in PTO	1.99	5.23	4.78	5.06	2.66
Median	1.84	4.72	4.18	4.31	2.23
Mode	1.70	4.10	3.49	3.23	2.85
Std. Dev.	0.76	2.55	2.61	2.73	1.55
Max	7.88	18.15	18.15	18.15	12.79
Min	0.67	1.36	1.28	1.53	0.82

TOTREF 1 52.3760 **0.0001**

US references

LR Statistics For Type 3 Analysis

Source DF ChiSquare Pr>Chi

USPREF 1 30.2539 **0.0001**

Foreign references

LR Statistics For Type 3 Analysis

Source DF ChiSquare Pr>Chi

FORPREF 1 19.8184 **0.0001**

Non references

LR Statistics For Type 3 Analysis

Source DF ChiSquare Pr>Chi

NPREF 1 26.7643 **0.0001**

These results are not terribly surprising. There was a strong relationship between refilings of all types and the length of time an application spent in prosecution. Patents that issued based on the instant application spent less than two years in prosecution on average, and the median patent in this group spent only 1.84 years in prosecution.[95] By contrast, patents with at least one refiling of any sort – continuation, CIP, or divisional – spent around five years on average in the prosecution process. The maximum time was also much longer than for patents without any history of refiling: 18.15 years. It is worth noting, however, that the patent in question was abandoned and refiled several times during that period.[96]

A more interesting result concerns patents claiming foreign priority. Foreign priority under the Paris Convention or the PCT is not counted against the new 20-year term, and we have not included the foreign filing date in our calculations of "time spent in prosecution." Nonetheless, patents claiming foreign priority (largely but not exclusively patents owned by foreigners)[97] spent significantly longer in prosecution once they reached the U.S. (2.66 years on average) than patents that did not claim any foreign priority date. This does not, however, mean that foreign patents spent longer in prosecution.[98] Because some foreign priority patents also included abandonments and refilings in the U.S. prosecution process, they naturally spent longer in prosecution than the subset of U.S. patents that issued based on the instant application. Rather,

95 There were, however, some cases of significant delay in prosecution even in this group. One patent application spent 7.88 years in prosecution, without being abandoned and refiled. In the future, the American Invention Protection Act will provide term extensions in many such cases.

96 The period we studied included patent applications filed both before and after June 8, 1995, when the change in patent term took effect. Applications in our sample first filed before that date get the benefit of the *longer* of 17 years from issue or 20 years from filing. 35 U.S.C. § 154(c)(1). Thus, those patents in this sample with long prosecution histories will not lose protection as a result of the time spent in prosecution.

97 *See supra* note __ and accompanying text (discussing the relationship between foreign priority and foreign ownership).

98 In fact, when we tested this relationship directly, the opposite was true: foreign patents issued more quickly than U.S. patents. *See supra* Table __.

the relevant comparison is between all patents with foreign priority and all patents in general. When we make this comparison directly, patents with foreign filing priority actually spend somewhat less time in prosecution in the U.S. (2.66 years on average) than patents overall (2.77 years on average).[99]

b. Relationships Based on Time in Prosecution

We tested a number of relationships between the time an application spent in prosecution and other aspects of the prosecution process: small entity status, the number and type of prior art references cited, and the number and type of claims filed.[100]

First, we tested the relationship between time in prosecution and small entity status, including both the fact of small entity status and the nature of that status (individual, non-profit or small business). The results are reported in Table 27.

Table 27

Time in Prosecution by Entity Size

Q41	Individual	Small Bus.	Non-Profit	Tot. Sm. Ent.	Large Ent.
Avg yrs in PTO	2.60	2.55	3.62	2.62	2.83
Median	1.97	2.16	3.09	2.13	2.28
Mode	1.38	2.10	#N/A	1.38	2.11
Std. Dev.	2.05	1.30	2.33	1.83	1.81
Max	18.15	7.61	8.85	18.15	13.98
Min	0.67	0.80	0.71	0.67	0.69

The data reject the supposition advanced by some[101] that the PTO process is stacked against individuals and small entities, at least where time spent in prosecution is concerned. Instead, the

---

99 The median patent in both groups is virtually identical, however: 2.23 years for foreign priority patents, compared with 2.22 years for all patents.

100 The relationship between time spent in prosecution and the number of applications filed is reported *supra* notes __-__ and accompanying text.

evidence suggests that large entities spend more time in prosecution (2.83 years on average, and a median of 2.28 years) than small entities (2.62 years on average, and a median of 2.13 years). Individuals and small businesses fare somewhat better than small entities as a whole; non-profit organizations fare worse. Indeed, the median patent to an individual issued in less than two years. These differences by entity size are statistically significant – size matters.[102]

c. Relationships Based on Entity Size

Finally, we tested a number of relationships between small entity status and other variables in the prosecution process, including number of inventors, number and type of prior art references, and number and type of claims.[103]

First, we tested the relationship between small entity status and the number of inventors listed on the patent. The results are reproduced in Table 30.

---

101 *See, e.g.,* Dana Rohrabacher & Paul Crilly, *The Case for a Strong Patent System,* 8 **Harv. J. L. & Tech.** 263 (1995); Len S. Smith, *Promoting the Progress of Science and America's Small Entity Inventors*, 77 **Wash. U.L.Q.** 585 (1999).

102 We used a Gamma regression.
Test Result:
Small vs. Large

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ENTISIZE	1	4.3483	**0.0370**

By each category (with individual as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
NPROFIT	1	4.4025	**0.0359**
SBIZ	1	0.0964	**0.7561**
LBIZ	1	3.5224	**0.0605**

103 Other prosecution factors relating to entity size, such as its relationship with the number of applications filed and with time spent in prosecution, are explored *supra* notes __-__ and accompanying text and notes __-__ and accompanying text.

Table 30

Number of Inventors by Entity Size

Q9	Individual	Small Bus.	Non-profit	Tot. Sm. Ent.	Large Ent.
Avg # Inventors	1.47	1.89	2.82	1.67	2.50
Median	1	1	2	1	2
Mode	1	1	2	1	1
Std. Dev.	1.04	1.18	1.78	1.16	1.59
Max	10	7	7	10	11
Min	1	1	1	1	1

As one might expect, there is a strong positive relationship between the size of the entity that owns the patent and the number of inventors listed on the patent. Large entities list 2.50 inventors on average, and the median large entity patent has two named inventors. By contrast, small entity patents have only 1.67 inventors on average, and the median small inventor patent has only one inventor listed. Further, within the small entity category, patents owned by individuals have fewer named inventors (1.47 on average) than patents owned by small businesses (1.89 on average).[104]

Next, we tested the relationship between entity size and the number and type of prior art references cited. The results are reprinted in Table 31.

[104] Contrary to what one might think, the fact that a patent is not assigned to a corporation (and therefore is listed here as "Individual") does not necessarily mean that there is only one inventor. In some cases individuals collaborate on an invention, and own the resulting patent as joint inventors, or assign rights in the patent to one of the named inventors rather than to a corporate entity.

Table 31

Prior Art References by Entity Size

U.S. Patent References

Q13	Individual	Small Bus.	Non-Profit	Tot. Sm. Ent.	Large Ent.
Avg # US pat ref	13.03	11.41	10.36	12.34	9.52
Median	9	8	5	9	6
Mode	6	5	25	6	5
Std. Dev.	12.89	10.67	10.69	12.04	12.25
Max	87	65	29	87	137
Min	0	0	0	0	0

Foreign Patent References

Q17	Individual	Small Bus.	Non-Profit	Tot. Sm. Ent.	Large Ent.
Avg # For pat ref	1.63	2.17	0.82	1.80	2.71
Median	1	1	0	1	1
Mode	0	0	0	0	0
Std. Dev.	2.98	3.81	1.47	3.28	4.20
Max	21	19	4	21	43
Min	0	0	0	0	0

Non-Patent References

Q21	Individual	Small Bus.	Non-Profit	Tot. Sm. Ent.	Large Ent.
Avg # non-pat ref	1.48	4.45	15.09	3.08	2.08
Median	0	0	4	0	0
Mode	0	0	0	0	0
Std. Dev.	5.12	11.04	20.82	9.08	5.15
Max	49	68	67	68	55
Min	0	0	0	0	0

Total References

Q25	Individual	Small Bus.	Non-Profit	Tot. Sm. Ent.	Large Ent.
Avg # total ref	16.14	18.03	26.27	17.21	14.31
Median	11	13	25	12	10
Mode	11	6	16	6	7
Std. Dev.	16.15	18.32	18.85	17.13	15.86
Max	105	118	72	118	163
Min	1	0	3	0	0

The results are significant[105] and somewhat surprising. Despite their larger resources, large entities cite less prior art than small entities (14.31 total references on average, compared with

---

105 We used a Poisson regression.
Test Result:
Total references –

Small vs. Large

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ENTISIZE	1	112.1334	**0.0001**

By each category (with individual as the baseline):
LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
NPROFIT	1	54.6478	**0.0001**
SBIZ	1	13.9674	**0.0002**
LBIZ	1	31.2177	**0.0001**

US patent references –

Small vs. Large
LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ENTISIZE	1	153.9645	**0.0001**

By each category (with individual as the baseline):
LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
NPROFIT	1	6.0966	**0.0135**
SBIZ	1	14.1493	**0.0002**
LBIZ	1	159.0887	**0.0001**

Foreign patent references –

Small vs. Large
LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ENTISIZE	1	75.1942	**0.0001**

17.21 for small entities).[106] This result carries over to U.S. patent references and to non-patent prior art: in both cases, small entities are likely to cite more such art than large entities. By contrast, large entities are likely to cite significantly more *foreign* patent references than small entities (2.71 on average, compared with 1.80 for small entities). This difference could reflect either the larger resources for a search available to large entities, but if so it is hard to explain the result for U.S. patents and non-patent references. More probably, the result reflects the greater

---

By each category (with individual as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
NPROFIT	1	5.1729	**0.0229**
SBIZ	1	10.3400	**0.0013**
LBIZ	1	72.6740	**0.0001**

Non-patent references –

Small vs. Large

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ENTISIZE	1	81.9384	**0.0001**

By each category (with individual as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
NPROFIT	1	401.7654	**0.0001**
SBIZ	1	215.8163	**0.0001**
LBIZ	1	27.7535	**0.0001**

106 Because "cited prior art" is a combination of prior art cited by the applicant and art found by the patent office, it is not necessarily the case that the art in question was actually cited by the applicant and not the examiner. However, we have no *a priori* reason to believe that examiners are likely to cite more art against small entities than against large entities (indeed, it is not clear that they would even know the difference). The differences are more likely to result either from the area of technology at issue, or from the art provided by the applicant.

likelihood that a large entity filed its application in multiple countries, and therefore had more foreign prior art cited against it by foreign examiners.[107]

Finally, we tested the relationship between small entity status and the number and type of claims in the patent. The results are presented in Table 32.

Table 32

Number and Type of Claims by Entity Size

Independent Claims

Q33	Individual	Small Bus.	Non-Profit	Tot. Sm. Ent.	Large Ent.
Avg # ind claims	2.23	3.36	3.45	2.69	2.78
Median	2	3	3	2	2
Mode	1	2	1	1	1
Std. Dev.	1.54	2.99	2.84	2.29	2.19
Max	8	17	10	17	24
Min	1	1	1	1	1

Dependent Claims

Q37	Individual	Small Bus.	Non-Profit	Tot. Sm. Ent.	Large Ent.
Avg # dep claims	11.15	14.16	28.45	12.90	11.80
Median	10	13	12	11	9
Mode	0	3	35	5	2
Std. Dev.	8.91	10.88	32.63	11.76	9.93
Max	47	71	115	115	80
Min	0	0	1	0	0

Total Claims

Q29	Individual	Small Bus.	Non-Profit	Tot. Sm. Ent.	Large Ent.
Avg # total claims	13.38	17.51	31.91	15.59	14.58
Median	12	16	19	13	12
Mode	20	4	13	20	10
Std. Dev.	9.76	12.40	33.30	12.84	10.84
Max	55	80	120	120	82
Min	1	1	2	1	1

[107] Companies that have prior art cited against them by a foreign patent office generally have an obligation to disclose that prior art to the U.S. PTO in prosecuting the U.S. companion application. *See, e.g.,* Molins PLC v. Textron, Inc., 48 F.3d 1172 (Fed. Cir. 1995).

The results do not show major differences in the number and type of claims between small and large entities. There are greater differences within each category of small entity: individuals file fewer claims of each type than any other entity, and non-profits file the most claims.[108] Most, but not all, of the differences are statistically significant.[109]

---

[108] The conclusion with respect to non-profits is suspect, however, because of the small sample size (only 11 of the 1,000 patents in the sample were filed by non-profits).

[109] We used a Poisson regression.
Test Result:
Total claims –

Small vs. Large
LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ENTISIZE	1	14.0773	**0.0002**

By each category (with individual as the baseline):
LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
NPROFIT	1	186.1558	**0.0001**
SBIZ	1	74.3813	**0.0001**
LBIZ	1	14.1936	**0.0002**

Independent claims –

Small vs. Large
LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ENTISIZE	1	0.6590	**0.4169**

By each category (with individual as the baseline)

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
NPROFIT	1	5.9076	**0.0151**
SBIZ	1	30.9016	**0.0001**
LBIZ	1	16.6640	**0.0001**

Dependent claims –

IV. Conclusions

While there is a wealth of interesting results in this data, the following facts about modern patents stand out to us:

- Patents are not exclusively (or even primarily) granted for inventions that a layperson would think of as "high-tech." The largest single category of inventions patented during 1996-1998 was mechanical patents. On the other hand, there were a large number of patents in certain fields of technology, especially software, computers, and semiconductors.[110]
- U.S. patentees come from a very few countries. More than half of all U.S. patents originate in the U.S., and more than 97% come from just 12 countries around the world. The overwhelming majority of U.S. patents come from inventors in the developed world.
- The average time a patent spends in prosecution has increased significantly since 1994, from 2.37 years[111] to 2.77 years. Whatever the explanation (the significant increase in applications

Small vs. Large

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
ENTISIZE	1	20.6063	**0.0001**

By each category (with individual as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	ChiSquare	Pr>Chi
NPROFIT	1	188.6882	**0.0001**
SBIZ	1	47.9340	**0.0001**
LBIZ	1	5.0115	**0.0252**

110 Patents of this sort were significantly more prevalent in this sample than they were in our prior study of which patents were actually *litigated* in the 1989-1996 period. *See* Allison & Lemley, *supra* note __, at 217 (refers to software and computer-related patents; semiconductors were not identified as an area of technology in our recent study of litigated patents).

111 *See* Lemley, *supra* note __, at 383-84 (average time in prosecution 864 days).

and greater use of abandonment practice are two likely possibilities), the increased time in prosecution put pressure on the 20-year patent term law.

- Patents tend to be granted to corporations and to collaborative groups of inventors, not to individuals working alone. More than 80% of all patents are assigned to a company, and the typical patent has more than one listed inventor. Further, small entities (mostly individuals and small businesses) patent a large number of mechanical inventions and medical devices, but a very small percentage of most other sorts of inventions.
- Patents as a whole cite very little non-patent prior art. The overwhelming majority of the art cited by the patentee and the examiner consists of other patents, even in industries where many inventions are not recorded in that form. Among industries, however, software patents actually cite more non-patent art than average.
- Different countries patent different types of technology. Interestingly, and contrary to the conventional wisdom, U.S. inventors are *overrepresented* relative to other nations in mechanical inventions, medical devices, pharmaceuticals, and biotechnology, and are underrepresented in computer, software, semiconductor, and electronics inventions.
- Patents in different areas of technology differed significantly in the prosecution process they endured. Chemical, pharmaceutical, and biotechnology patents had a much more involved prosecution process than average. Patent applications in all three areas were significantly more likely to be abandoned and refiled by the applicant one or more times. They spent significantly longer in prosecution than other sorts of patents, perhaps because of the refilings.[112] And the patents that ultimately issued in these fields cited significantly more

[112] Not surprisingly, we found that abandoning and refiling an application added significantly to the time spent in prosecution.

prior art than average. By contrast, electronics and mechanics patents spent much less time in prosecution, were less likely to be abandoned and refiled, and cited fewer references.[113] The impression that the data leave is of a patent prosecution system that spends much more time and attention on some sorts of patents than others.

- U.S. patents spend longer in prosecution than foreign patents. This may, however, be related to the prior two findings: U.S. patents are disproportionately in technology areas that spend longer than average in prosecution. It is also likely related to another finding in the study: U.S. patentees engage in the practice of abandonment and refiling to a greater extent than nationals of any other country.
- U.S. patentees are more likely to be small entities than foreign patentees. There is a tremendous variance by country, however; Japanese patents are almost never owned by small entities, while in the U.S., Taiwan, and several other countries, 40% or more of the patents are owned by small entities.
- U.S. patents also cite many more prior art references than foreign patents, though once again this may be a function of the area of technology.
- Patents owned by small entities spend significantly *less* time in prosecution than patents owned by large entities, despite the protestations to the contrary at recent Congressional hearings. However, small entity patents cite *more* prior art on average than do large entity patents.

We hope that this information will be useful to practitioners, courts and policy-makers, all of whom need a firm grounding in how the patent system actually works before they can endeavor to use or change it.

---

113 Software patents were an exception to this general industry trend. They spent longer than average in prosecution, despite the fact that they were not often abandoned and refiled.