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

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I. INTRODUCTION

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 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 are 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 obtaining patents in what areas of technology and what characterizes those patents. To accomplish this, we collected a random sample of 1000 utility patents issued between 1996 and 1998. We then identified a large number

4. PTO statistics indicate that it issued 163,209 patents in 1998, up from 124,146 in 1997. *See PTO Patents Up in 1998*, 57 Pat. 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, *available at* http://www.uspto.gov/web/offices/com/annual (last visited Nov. 21, 1997). Data for those representative years are:

Year	US Pats.	Foreign Pats.	Total Pats.	% Foreign
1983	32,871	23,989	56,860	42.2%
1986	38,126	32,734	70,860	46.2%
1989	50,185	45,354	95,539	47.5%
1992	59,760	49,968	109,728	45.5%
1995	64,562	49,679	114,241	43.5%

5. *See* Mark A. Lemley, *Reconceiving Patents in the Age of Venture Capital*, 4 J. SM. & EMERGING BUS. L. 137, 138 (2000) (performing this calculation). For more detailed statistics, see Mark A. Lemley, *Rational Ignorance at the Patent Office*, 95 NW. U. L. REV. (forthcoming 2000) [hereinafter Lemley, *Rational Ignorance*]. This number reflects only the cost of paying lawyers' and PTO fees and does not include the cost to clients of lost time and productivity.

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, such as how nationality relates to area of technology and how the size of the patentee relates to the prosecution process. In so doing, we hope to advance the understanding that both scholars and practitioners have about modern trends in patent prosecution.[6]

Our most significant findings are:

- 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.[7]
- 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[8] to 2.77 years. Whatever the explanation,[9] the increased time in prosecution puts 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

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 two-year period from twenty years earlier (mid-1976 to mid-1978), and comparing the results of that study with the results of the present study.

7. Software and computer-related patents were significantly more prevalent in this sample than they were in our prior study, which included patents that were actually *litigated* during the 1989-1996 period. *See* John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 AIPLA Q.J. 185, 217 (1998) (noting that semiconductors were not identified as an area of technology in our recent study of litigated patents).

8. *See* Mark A. Lemley, *An Empirical Study of the Twenty-Year Patent Term*, 22 AIPLA Q.J. 369, 383-85 (1994) (reporting that in 1994, patents spent an average of 864 days in prosecution).

9. Two likely possibilities include the significant increase in applications and greator use of conintuation practice during the transition period from the 17 to 20-year patent terms.

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.[10] And the patents that ultimately issued in these fields cited significantly more prior art than average. By contrast, electronics and mechanical patents spent much less time in prosecution, were less likely to be abandoned and refiled, and cited fewer references.[11] The impression that the data leaves 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 two other findings: U.S. patents disproportionately deal with technology areas that spend longer than average in prosecution, and U.S. patentees engage in the practice of aban-

10. Not surprisingly, we found that abandoning and re-filing an application added significantly to the time spent in prosecution.

11. Software patents were an exception to this general industry trend, taking longer than average to prosecute despite the fact that they were not often abandoned and refiled.

donment and refiling to a greater extent than patentees of any other country.

- U.S. patentees are more likely to be small entities than foreign patentees. There is a tremendous variance by country; 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 proceed in four parts. In Part II, we survey the existing empirical literature on patents. In Part III, we explain the methodology of our study. We then present the results of our study in Part IV. Finally, we conclude in Part V by highlighting some of the implications of our data.

II. EXISTING LITERATURE

The lack of empirical evidence on the function and impact of the patent system has long been lamented.[12] 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 patent, (2) what happens to patents after they are issued, and (3) what sorts of things are patented.[13]

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12. George Priest complained years ago that there was virtually no useful economic evidence addressing the impact of intellectual property. *See* 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 OF THE SENATE COMM. ON THE JUDICIARY, 85TH CONG., AN ECONOMIC REVIEW OF THE PATENT SYSTEM 55 (Comm. Print 1958) (prepared by Fritz Machlup). For a discussion of 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.

13. A fourth sort of work not catalogued here concerns the relationship between patents and economic development. For work along these lines, see Zvi Griliches, *Patent Statistics as*

First, several researchers have focused attention on how patents are perceived and used by firms in various economic sectors. The 1987 study by Levin, Klevorick, Nelson, and Winter is a prominent example.[14] 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.[15] Although the authors found significant inter-industry variances, companies generally did not view patents as the most effective means of encouraging innovation.[16] Indeed, in some industries, patents were considered the least effective contributor to innovation.[17]

Economic Indicators: A Survey, 28 J. ECON. LIT. 1661 (1990); JOSH LERNER, 150 YEARS OF PATENT PROTECTION (National Bureau of Econ. Research Working Paper No. W7478, 2000).

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

15. *See id.*

16. *See id.*

17. *See id.* at 798. Not surprisingly, patents were viewed as much less effective for processes than for products. *See id.* at 794-95. Among the most important reasons found by the authors for the perceived limitations on the effectiveness of patents were the ease of inventing around both process and product patents and doubts about patentability in the case of processes. *See id.* at 803. Given their findings, the authors were led to question why firms were patenting at an increasing rate. Although their research did not explore this question, a recent study by Wesley Cohen and others directly addresses it. *See* Wesley M. Cohen et al., Appropriability Conditions and Why Firms Patent and Why They Do Not in the American Manufacturing Sector, Paper Presented at the Stanford Workshop on Intellectual Property and Industry Competitive Standards, Stanford Law School April 17-18, 1998 (on file with authors). Before seeking to answer this question, the Cohen study updates Levin's and finds that, across many manufacturing sectors, patonts are viewed as substantially less effective for appropriating the value of product innovations than all other altornatives, with secrecy and lead time being the most preferred alternatives. *See id.* 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. *See id.* The authors recognize, however, that the importance of this reason could have been exaggeratod because many respondents may have viewed this as the most "socially desirable response." *Id.* The second most important reason was "blocking," or preventing other firms from patenting related technology. *Id.* Blocking and related defensive motives may help explain our finding that patent litigation commonly occurs long after the issuance of a patent. *See* Allison & Lemley, *supra* note 7, at 237-38; *see also* Samuel Kortum & Josh Lerner, *What is Behind the Recent Surge in Patenting?*, 28 RES. POL'Y 1 (1999) (examining why firms are increasingly seeking patents and rejecting the explanation that the surge is due te changes in patent law). *But see* Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 94-98 (1999).

For examples of other work along these lines, see John Bound et al., *Who Does R & D and Who Patents?*, *in* PATENTS, R&D AND PRODUCTIVITY (Zvi Griliches ed. 1984); Zvi Griliches et al., *R&D, Patents and Market Value Revisited: Is there a Second (Technological Opportunity) Factor?*, 1 ECON. INNOV. & NEW TECH. 183 (1991).

For a more detailed exploration of trends in patenting on an industry-by-industry basis, see John H. Barton, The Impact of Contemporary Patent Law on Plant Biotechnology Research, Paper Presented at the Stanford Workshop on Intellectual Property and Industry Competitive

Second, many studies have attempted to determine what people actually do with patents once they get them, and the related question of 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.[18] Several other authors have evaluated patent acquisition and licensing strategies in various industries through case studies.[19] 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.[20] One of Lerner's key findings was that firms with relatively high litigation costs are less likely to seek patents in those subclasses in which there had been many patent damage awards to rivals,[21] especially compared to those firms with lower litigation costs.[22]

A smaller number of empirical studies have been conducted on patent litigation. There are three comprehensive studies (including a recent one we conducted) on how patents fare in litiga-

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Standards, Stanford Law School, April 17-18, 1998 (on file with authors); BRONWYN HALL & ROSEMARIE HAM ZIEDONIS, THE PATENT PARADOX REVISITED: DETERMINANTS OF PATENTING IN THE U.S. SEMICONDUCTOR INDUSTRY, 1980-1994 (National Bureau of Econ. Research Working Paper No. W7602, 1999).

18. *See generally* JEAN O. LANJOUW ET AL., HOW TO COUNT PATENTS AND VALUE INTELLECTUAL PROPERTY: USES OF PATENT RENEWAL AND APPLICATION DATA (National Bureau of Econ. Research Working Paper, 1996) (accounting for the extent firms value patents by examining renewal data and multi-country filings); *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 Adam B. Jaffe & Manuel Trajtenberg, *International Knowledge Flows: Evidence From Patent Citations,* 8 ECON. INNOV. & NEW. TECH. 105 (1999); BRONWYN H. HALL ET AL., MARKET VALUE AND PATENT CITATIONS: A FIRST LOOK (National Bureau of Econ. Research Working Paper No. W7741, 2000).

19. *See* 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 (1998); Robert P. Merges, *Contracting Into Liability Rules: Intellectual Property Rights and Collective Rights Organizations,* 84 CAL. L. REV. 1293 (1996); Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scopo,* 90 COLUM. L. REV. 839 (1990); David J. Teece, *Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy,* 15 RES. POL'Y 285 (1986).

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

21. *See id.* at 463, 478-79. These subclasses (over 120,000 total) exist within the patent classification system maintained by the PTO. *See id.* at 466. Lerner's finding means that firms with relatively high litigation costs are more likely to use litigation-avoidance patenting strategies.

22. *See id.* 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 te the literature on the various effects that litigation and other dispute resolution costs have on firms' behavior.

tion.[23] 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.[24] They evaluated a sample of 252 patent suits, testing the hypothesis that preliminary injunctive relief in patent litigation is used to impose costs on rivals.[25] Coolley has also produced a useful empirical study of a purely descriptive nature on patent infringement damages.[26] Lanjouw and Schankerman evaluated data provided by the PTO about litigated patents to determine the ways in which litigated patents differ from the general patent pool.[27] At least two other studies have at-

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23. 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 courts' treatment of uncited and cited prior art. *See* 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. *See id.* at 236. He also concluded that the prior art before the courts was often better than that 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 than on the basis of cited prior art. *See id.* at 249. Our data in a prior study confirm this observation. *See* Allison & Lemley, *supra* note 7, at 231-34.

The second study, first published by Koenig in 1974 and then updated through 1980, constitutes the most extensive set of data ever gathered on patent litigation. *See* GLORIA K. KOENIG, PATENT INVALIDITY: A STATISTICAL AND SUBSTANTIVE ANALYSIS (rev. ed. 1980). Koenig collected all patent cases reported in the *U.S.P.Q.* in the years 1953-1978 to produce an array of descriptive statistics. *See id.* at 5-70 to 5-78. She also selected a random sample of 150 patents from the years 1953-1967 for more in-depth study. *See id.* Koenig looked at the various kinds of prior art relied on by courts, and the ways in which uncited prior art played a role in the courts' decisions. *See id.* at 5-25 to 5-69. 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. *See id.* at 4-41 n.35.2. Finding that most courts held patents invalid, Koenig noted the wide disparity of validity rates across regional circuits and concluded that obviousness (or "lack of invention") was the most frequently used basis for judicial invalidation of patents. *Id.* at 5-70 to 5-78.

The third and most recent comprehensive study is the one we conducted in 1998 covering all final written decisions on patent validity from 1989 through 1996. *See* Allison & Lemley, *supra* note 7.

24. *See* JEAN O. LANJOUW & JOSH LERNER, PRELIMINARY INJUNCTIVE RELIEF: THEORY AND EVIDENCE FROM PATENT LITIGATION (National Bureau of Econ. Research Working Paper No. 5689, 1996).

25. *See id.* Lanjouw and Lerner find that their data is consistent with tbe hypothesis that preliminary injunctive relief is a predatory weapon in patent cases. *See id.*

26. *See* 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. *See id.* 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, the U.S.P.Q., and Lexis.

tempted, with mixed success, to empirically analyze the decision-making behavior of the United States Court of Appeals for the Federal Circuit.[28]

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 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 context of biotechnology patents, evaluating in one particular industry many of the characteristics we examine here across all in-

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27. *See* JEAN O. LANJOUW & MARK SCHANKERMAN, STYLIZED FACTS OF PATENT LITIGATION: VALUE, SCOPE AND OWNERSHIP (National Bureau of Econ. Research Working Paper No. W6297, 1997).

28. *See* Renald B. Coolley, *What 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 te use as a basis for any type of statistical conclusion. In addition to not identifying the source of its data or attempting a precise definition of its data set, the study 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 Dunner study, on the other band, provides much more useful descriptive statistics. This research had the avowed objective of determining whether the Federal Circuit was "biased" in favor of patents. Dunner et al., *supra*. Specifically, Dunner examined whether the Federal Circuit is generally more pro-patent than its predecessor patent appeals courts, namely, the regional circuits and the Court of Custems and Patent Appeals ("C.C.P.A."). The study was hased on 1302 Federal Circuit decisions of all kinds, many unreported; the source of the data set is not clear. Although based on a very large data set that may present data comparability problems, the study does include one portion that segregates Federal Circuit decisions on patent validity. Like other studies of the Federal Circuit, the Dunner study found a much higher validity rate in the Federal Circuit 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. *See* Dunner et al., *supra*, at 154. For other works in tbe area attempting to catalogue particular aspects of Federal Circuit decisions, see John R. Allison & Mark A. Lemley, *How Federal Circuit Judges Vote in Patent Validity Cases*, 27 FL. ST. U. L. REV. (forthcoming 2000); Rochelle Cooper Dreyfuss, *The Federal Circuit: A Case Study in Specialized Courts*, 64 N.Y.U. L. REV. 1 (1989).

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. *See* Federal Courts Improvement Act of 1982, P.L. 97-164, 96 Stat. 25, 37 (codified as amended at 28 U.S.C. § 1295 (1994)). Although not relevant to our study, the same legislation also gave the newly created Federal Circuit appellate jurisdiction over appeals from decisions of the PTO'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 the province of the C.C.P.A, the existence of which was extinguished by the 1982 legislation. *See id.*

dustries.[29] Other studies cut across industries, but study only one particular aspect of the prosecution process.[30] To our knowledge, however, ours is the first comprehensive study of the relationship between multiple characteristics of patents across all major areas of technology.

III. DESCRIPTION OF THE STUDY

We collected a random sample of 1,000 utility patents issued in the United States during a two-year period. 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.[31]

For each patent in the sample, we obtained a wide variety of information including the following: (1) PTO classification number and PTO technology group (mechanical, chemical, or electrical); (2) area of technology, among the 14 technology groups we defined, and number of technology areas into which each patent fell;[32] (3) the invention's country of origin;[33] (4) filing date, U.S. and foreign priority dates, issue date, and time spent in prosecution;[34] (5) the number and type of filings to which each patent claimed priority, if any; (6) small or large entity status and type of entity; (7) the number of inventors; (8) whether the patent had been assigned; (9) whether the patent had a foreign assignee, and whether it had at least one foreign inventor; (10) the number and type of prior art

29. *See* Daniel K.N. Johnson, Biotechnology Inventions: What Can We Learn From Patents? (unpublished manuscript, 2000) (on file with authors).

30. *See, e.g.*, 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) (studying time spent in prosecution); Mark A. Lemley, *An Empirical Study of the Twenty-Year Patent Term*, 22 AIPLA Q.J. 369 (1994) (same).

31. When a sample is truly random, the larger the sample, the more likely it will include duplicate numbers. Knowing that this would be the case, to obtain a sample of 1,000 patent numbers, we selected an initial sample of 1,050 randomly generated numbers. Fourteen of the numbers were duplicates and were discarded. We then substituted the next 14, numbers 1,001-1,014. The remainder of the initial 1,050 numbers were discarded. This method was a matter of necessity that does not affect the randomness of the sample.

32. For more information on how we defined these groups, see *infra* text accompanying notes 35-39.

33. For more information on how we defined country of origin, see *infra* text accompanying notes 44-51.

34. Time spent in prosecution was determined by subtracting the *first* U.S. priority date from the issue date.

references cited on the face of the patent; and (11) 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 classify the patents in our sample into areas of technology that we have defined ourselves.[35] 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.[36] Small entities are further divided into three categories: individuals, non-profit organizations, and small businesses.[37] 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 is at least as reasonable as other possible alternatives. While it is possible to devise an almost endless list of categories and subcategories, we chose the fourteen categories in this study because they reflect the areas of technology into which inventions in the sample generally fell. In many cases the categories also have significance in larger policy debates. For example, while we could have decided not to separate out software patents from the computer-related category, there is enough debate about software patents that we thought it worth analyzing them separately.[38] Following are the definitions of technology areas employed

35. Similarly, we did not use the "Canadian Concordance" between PTO classifications and industries because we believe the PTO classifications themselves are sometimes suspect.

36. The report is made by the applicant and is not verified by the PTO. *See* U.S. PATENT & TRADEMARK OFFICE, MANUAL OF PATENT EXAMINING PROCEDURE §509.03 (7th ed. West 1998). Misrepresenting entity size is illegal and can theoretically invalidate the patent. *See* 37 C.F.R. § 1.9(f) (1999); *but cf.* DH Tech. Inc. v. Synergystex Int'l, 154 F.3d 1333 (Fed. Cir. 1998) (noting that innocent failure to pay large entity fee can be corrected later). Thus, these self-reports generally should be accurate.

37. An entity is defined by the PTO as "small" if it meets the requirements of 35 U.S.C.A. § 41(h)(1) (West 1984 & Supp. 2000), which incorporates by reference section 3 of the Small Business Act.

38. The patonts collected in our study were issued before the Federal Circuit's 1998 decision in *State Street Bank & Trust Co. v. Signature Fin. Group, Inc.*, 149 F.3d 1368 (Fed. Cir. 1998), which permitted the patenting of "business methods." *Id.* We therefore did not attempt te

in this study, listed in the order 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, including 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.[39]

(2) Medical device: An apparatus to be used for the diagnosis or treatment of diseases in humans or animals including apparatuses used in medical research. An invention classified as a medical device will normally 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.

(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, even if the claims of the patent refer to a system or article of manufacture. 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 practi-

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hreak out business methods into a separate technology area. In any event, we did not encounter any patents in our sample that fit the business methods category.

39. In an almost identical study we are doing on 1,000 randomly selected patonts from mid-1976 te mid-1978, we plan to separately analyze that 20-year-earlier data set and compare those results with the results from this study. All of the patents in the 1970s sample 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.

cally 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 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; or 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. While many different types of inventions fit into this category, it should not be confused with a catchall "other" category.

(10) Acoustics: A process or product that consists solely or as a critical part of an invention using sound waves. Such an invention 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 as 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 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 (for example, seismological inventions for detection of oil and gas), optics, chemistry, or 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, 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.[40] 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.[41]

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 and related them to each other. These relationship tests are all bivariate, not multivariate.[42] Thus, we can predict with confidence that two characteristics are related to each other, for example, the invention's country of origin and mean time spent in prosecution. However, it is likely that other factors, such as area of technology or number of applications filed, contribute to explaining this relation-

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40. 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.

41. 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. In Tables where we do report confidence intervals, they are reported as margins of error in each direction from the reported mean, and are calculated at a 95% confidence level.

42. In other words, we test only the relationship between two elements of the data we have collected, not the relationship among three or more of those elements.

ship. Thus, we wish to emphasize that we are *not* predicting cause and effect, merely correlation.

IV. RESULTS

We present our results in two broad categories. In Section A, we present the characteristics of the sample that we catalogued, such as country of origin, area of technology, and time spent in prosecution. 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 the following: 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 was 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.[43] 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.[44] 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. 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.[45] The results of this classification system, sorted by frequency, are presented in Table 1.

One striking result, even in the more finely tuned classification system we have used, is how many patents were issued for truly mechanical inventions: 329 out of 1,000 patents, or nearly one-third.[46] It is also notable how many inventions are in the general field of computer-related inventions: 242 patents or nearly one-

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43. 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* Lemley, *supra* note 30, at 388 tbl. 2. In that study, the PTO classified 29% of the patents as electrical and 29% as chemical. By contrast, in our current study, using patents issued from 1996 through 1998, a virtually identical 29.2% of the patents are chemical, but 33.4% are electrical.

44. 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 sought te advance the Optics and Computer-Related arts. (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. *See* U.S. PATENT & TRADEMARK OFFICE, PATENT DATABASE, *available at* http://www.uspto.gov/patft.

45. 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 infra* Table 1.

46. This is consistent with our earlier finding that most litigated patonts are in mechanical areas of technology. *See* Allison & Lemley, *supra* note 7, at 216-19. However, because that study used a somewhat different classification system, the results are not strictly comparable.

quarter, including 76 software inventions.[47] Finally, 128 patents were granted in optics and 22 in acoustics. The magnitude of these numbers may be surprising because the media generally does not pay much attention to optics or acoustics in their reporting on booming technology areas.

Assuming these numbers are representative of patents issued generally during this time period,[48] there are an enormous number of patents in force in many of these fields of technology. Approximately 237,000 patents were granted in the United States during the two years of our study.[49] Of these patents, our sample predicts that approximately 22,000 are semiconductor patents, and 18,000 are software patents.[50] 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 were surely issued in the periods before June 1996 and have been issued since May 1998.[51]

2. Country of Origin

We also classed each patent by country of origin. Twenty-five countries were represented in our sample; 12 of these countries had five or more patents issued.[52] In defining "country of origin," we were concerned with identifying the nation in which the invention

47. Our definition of a computer-related invention 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, semiconductor inventions were *not* included with the computer-related classification, but were included in a separate, mutually exclusive category. Therefore, they could be added to the computer-related category for the purpose of arriving at a total number of patents in the general computer area.

48. The numbers should be representative, given the randomness of the sample and the large sample size. *See generally* AMIR D. ACZEL, COMPLETE BUSINESS STATISTICS 230-58 (4th ed. 1999) (discussing confidence intervals and their measurement in several sets of conditions).

49. 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, tbl. A1 (March 1999) [hereinafter ALL TECHNOLOGIES REPORT]. Because our study covered only 24 months during those years, we have included in our sample 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. Tbese numbers are only estimates, however, tallying patents issued by year rather than month.

50. Tbese 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.

51. Greg Ahrenian estimates tbat there are now 80,000 software patents in force in the United States. *See* Greg Ahronian, *Internet Patent News Service*, http://www.bustpatents.com. While our numbers may be slightly more conservative than his, that estimate is not unrealistic.

52. 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).

itself originated. Thus, we generally looked at inventor domicile, with assignee location used as a sort of "tie-breaker."

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. These numbers are consistent with those identified by the PTO for the population of patents issued during this period.[53] Notably, few countries are represented on this list. The twelve countries listed in Table 2 together account for 97.3% 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 is demonstrated in Table 3.

There were virtually no patents issued to inventors in the developing world, with the exception of the fast-growing Asian economies of Korea, Taiwan, and Singapore. At least in the United States, patenting is done by inventors in the developed world.

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 85.1% figure, which represents the percentage of assignments in the sample as a whole. This suggests 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 pat-

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53. *See* ALL TECHNOLOGIES REPORT, *supra* note 49, at tbl. A1-2. Slight discrepancies result from the imperfection of predicting population characteristics from even a large sample and from the slightly different definitions of "country of origin" used by the PTO. *See id.* at tbl. A1-2 and accompanying text. The PTO defines "country of origin" to be the residence of the first-named inventer at the time the patent is issued. Although obviously easier than the approach we used to determine country of origin, it is a cruder method and is more likely than not to misrepresent the actual country in which the invention originated. *See supra* text accompanying notes 43-44. By contrast, we developed a more nuanced method for determining the country in which the invention originated.

ent owner. These characteristics belie the traditional and once-accurate notion of the typical inventor as an individual working alone in his garage. Today, large corporations are obtaining the overwhelming majority of patents.[54]

Most inventions in our study were 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.[55] Of the 293 small entities, 118 were organizations, including 11 non-profit organizations and 107 small businesses. Individuals prosecuted the remaining 175 patents, demonstrating that the individual inventor has certainly not disappeared from the scene altogether.

These facts may be useful in the modern debate over the nature of the patent system, though we are hesitant to draw any firm conclusions on that score. The most significant debates over patent reform of late have been debates about the impact of reform on individual inventors. Individual inventors successfully modified the 1999 American Inventors Protection Act to respond to their concerns about delay and to permit them to avoid publication of their patent applications.[56] They have also blocked efforts to move the U.S. from a "first-to-invent" to a "first-to-file" priority system, as the rest of the world has done. Notwithstanding these efforts, patenting in the U.S. today is something that is largely done by corporations, not individuals.[57]

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54. This supposition is borne out by the PTO statistics, which identify the entities—mostly large companies—that own the most patents. *See* ALL TECHNOLOGIES REPORT, *supra* note 49, at tbl. B.

55. Patents are always issued in the name of the individual inventor or inventors. *See* 35 U.S.C.A. §§ 115, 116 (1994), *amended by* 35 U.S.C. § 115 (Supp. IV 1998). 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* 35 U.S.C. §§ 118, 261 (1994).

56. *See* 35 U.S.C. §§ 122, 154(b) (West 1984 & Supp. 2000).

57. It remains open to debate whether this means that the U.S. should stop trying to favor individual inventors or redouble its efforts to do so.

4. The Prosecution Process

Finally, we collected a variety of data about the prosecution of the patents in the sample. Specifically, we studied the time spent in prosecution, the total number of continuations, continuations-in-part ("CIPs"), 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.

We studied the time spent in prosecution, which we define as the time from the filing of the *first* U.S. application to the issue date.[58] The question of how long patents spend in prosecution is particularly important now, because the patent term was changed in 1994 to run at least 20 years from the first filing date.[59] Thus, the longer a patent spends in prosecution, the less term it will generally have.[60] On average, the patents issued in our sample spent 1,011 days, or 2.77 years, in prosecution. 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.[61] Thus, it appears that patents issued in the 1996-1998 period took longer to get through the patent office than in 1994, which is a result opposite of that predicted by Lemley in 1994.[62]

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.[63] Thus, it may not

58. Thus, where a patent application claims priority to one or more prior applications, the date we report is the earliest priority date claimed. This is important because focusing only on the most recently filed application would understate the total time a patent application spent at the PTO. *See* Lemley, *supra* note 30, at 383-84.

59. *See* 35 U.S.C. § 154(a)(2) (1994).

60. The American Inventers Protection Act adds patent term in a number of cases involving appeal, interference, or delay by the PTO in issuing a patent. *See* 35 U.S.C. § 154 (b) (1994).

61. *See* Lemley, *supra* note 30, at 385 & tbl. 1.

62. *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.

63. *See* ALL TECHNOLOGIES REPORT, *supra* note 49, at tbl. A1.

be surprising that pendency times have increased, given that the workload of the PTO has increased markedly.[64]

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.[65] Because of uncertainty about patent terms under the 20-year rule, a larger-than-normal number of patent applications were filed in the weeks preceding the cut-off date.[66] Because that cut-off date occurred while the applications in this sample were being filed, these new filings may affect the characteristics of the sample. In particular, anyone engaged in the practice of "submarine patenting" would have a strong incentive to get a new application or CIP on file before June 8, 1995, in order to take advantage of the old 17-year patent term.[67] This may, in turn, result in a sample that is not truly representative because 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.[68]

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 out-

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64. We have not collected data on the number of Examiners during the 1994 or 1996-1998 periods. It is therefore impossible to tell for sure whether the workload per Examiner has increased.

65. *See generally* Lemley, *supra* note 30 (detailing the change).

66. In our sample, 32 applications claimed a priority date between May 22, 1995 and June 8, 1995, while only 11 claimed 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.

67. "Submarine patenting" is the deliberate delaying of the issuance of a patent in order to take a mature industry by surprise years later. *See generally* Lemley, *supra* note 30, at 377-80 (explaining how this can be accomplished).

68. 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 difference between the mean and median in the 1994 study was 163 days, compared to 200 days in our sample. *See* Lemley, *supra* note 30, at 385 tbl. 1. In percentage terms, however, the difference is minimal (23.3% of the median time in prosecution in 1994, compared te 24.7% in our sample).

side the U.S., this means that at least some foreign-owned patents were filed first in the U.S. rather than in their home country. 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 application, 111 via a CIP application, and 99 via a divisional application.[69] 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, 410 of the patents, did not claim priority to any previously filed application, in the U.S. 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 cited anywhere from a low of zero prior art references to a high of 163 references. The data are presented in Table 4.

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.[70] 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.[71] The predominance of U.S. patents may also reflect the limitations of the PTO systems for searching: the PTO is much more likely to find documents that it itself has generated. Given that in many fields the most relevant prior art is non-patent prior art, the predomi-

69. Because only some of the patents used more than one type of priority mechanism, we cannot merely sum these numbers to determine the numher of patents relying on prior U.S. applications.

70. Further, this data may, if anything, overstate the number of non-patent prior art references actually cited, since some apparently non-patent sources may in fact be reported abstracts of European Patent Office disclosures.

71. *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); *see also* Greg Ahronian, *Legal Resources and Tools for Surviving the Patenting Frenzy of the Internet, Bioinformatics, and Electronic Commerce*, INTERNET PATENT NEWS SERVICE, http://www.bustpatents.com (arguing that software patents are of doubtful validity because they cite very little non-patent prior art).

nance of patents in the art actually cited by the PTO suggests serious shortcomings in the PTO's validity investigation.[72]

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.

By itself, the number of claims in a patent does not tell us much. But it may be a proxy for the size or complexity of an invention, a possibility we return to below.

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 Country 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 five or more patents. The results are presented in Table 6.

Some differences are evident from this data. Compared to the overall numbers—37.4% mechanical, 29.2% chemical, and 33.4% electrical—U.S.-based inventors patent 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 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 deter-

72. While it does not necessarily follow that the PTO should beef up searching and prosecution, the reader should be aware of the limitations in the PTO's examination. *See* Lemley, *Rational Ignorance*, *supra* note 5.

mined that there is a strong, statistically significant relationship between PTO subject matter classification and country of origin.[73]

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.

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 computer-related patents; Japan, France, and the U.K. have more software patents; Japan, Korea, and Italy have more semiconductor patents; Canada has more electronic patents; Germany and France have more chemistry patents; Taiwan has more mechanical patents; Japan and Korea have more optical patents; and France has more 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.[74] This is demonstrated more

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73. 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
ffffffffffffffffffffffffffffffffffffffffffffffffffffff			
Chi-Square	2	12.837	0.002

Country-by country:

Statistic	DF	Value	Prob
ffffffffffffffffffffffffffffffffffffffffffffffffffffff			
Chi-Square	22	79.595	0.001

On the Chi-square test, see generally MICHAEL O. FINKELSTEIN & BRUCE LEVIN, STATISTICS FOR LAWYERS 159-65 (1990).

74. With respect to biotechnology, our study finds significantly more patents to be of U.S. origin than Daniel Johnson's work covering prior years. *See* Johnson, *supra* noto 29, at 23. This is likely because Johnson's definition of biotechnology is significantly broader than ours, including 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"). *Id.*; *see also* discussion *supra* Part III (providing our definition of biotechnology). It appears that U.S.-based patents were concentrated in these narrower categories.

clearly in Table 8. These relationships are strong and statistically significant.[75]

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 statistically significant relationship between country of origin and the number of areas of technology into which any given patent fell.[76]

We have not attempted here to read any social significance into these numbers. It is certainly possible to speculate why some countries patented disproportionately in the technologies they did. Are those countries preeminent in those fields? That is one possible

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75. 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

76. We used a Poisson linear model with a Chi-square test for significance. We refer to this approach hereafter as a "Poisson regression." *See generally* FINKELSTEIN & LEVIN, *supra* note 73, at 148-50 (discussing the Poisson regression between two variables).

Test Result:

Foreign vs. US:

LR Statistics For Type 1 Analysis

Source	Deviance	DF	Chi-Square	Pr>Chi
INTERCEPT	225.6527	0	0.0704	
ORIGIN	225.5823	1	0.7908	

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

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	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

explanation, though casual inspection suggests some surprises along those lines. Japan might be thought to excel in semiconductors and optics, for instance, but its overrepresentation in software and underrepresentation in electronics are harder to explain. Similarly, it seems implausible that the U.S. is behind the innovation curve in software, computer-related, and semiconductor inventions.

An alternative explanation might focus on the relative economic value of patents in different industries. Here the question is not so much one of a country's prominence in a particular field as the economic incentives to file patents abroad. Foreign inventors might not file applications in the U.S. for inventions they considered less valuable, or inventions for which the U.S. was unlikely to be a large market. By contrast, owners of valuable inventions are more likely to seek worldwide protection, and owners of inventions in certain fields like software may want protection in the U.S. even if they do not seek it elsewhere. This may explain why inventors in other countries disproportionately patent inventions in the pharmaceutical, semiconductor, computer-related, and software fields. It is not a full explanation for the differences we observe, however. For example, U.S. patentees dominate some areas of technology that seem especially valuable, like biotechnology. The market-based theory also explains otherwise surprising results about the patents prosecuted by U.S. inventors. Because U.S. inventors are likely to file here if they file anywhere, these "less valuable" inventions have not been filtered out by the decision to file abroad. Thus, the prevalence of mechanical inventions and medical devices among U.S. inventors may not say anything at all about the relative prominence of the U.S. in these fields. It may merely mean that mechanical inventors are less likely to file worldwide.

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 areas of technology, we again used two different measures, including the PTO classifications into mechanical, electrical, and chemical patents, and our more detailed classification into 14 more specific areas. However, we have focused our 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 versus large entity status, the number of inventors, the number and type of references cited, and number and type of claims filed.

First, we compared the number of U.S. applications filed by a particular applicant during the prosecution process to the area of technology.[77] The results are presented in Table 9.

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.[78]

There are at least two likely explanations for this difference. First, it may be that patent applicants in the chemical, pharmaceutical, and biotechnological fields consider patents more important to their business than patent applicants in other fields.[79] Thus, these applicants may have been willing to fight harder with the PTO to

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77. We should emphasize that we tested the number of times a particular application was "refiled" in whole or in part, including continuations, CIPs, and divisional applications. This is not a test of what percentage of applications actually issue as patents. On that issue, see Cecil D. Quillen Jr. & Ogden H. Webster, Continuing Patent Applications and Performance of the U.S. Patent Office (unpublished manuscript 2000) (on file with authors).

78. Using a Poisson regression, we obtained the following test results.

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	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

79. Some independent evidence te this effect can be found in two survey studies testing the importance of patents across industries, beth finding that companies in these fields reported heavier reliance on patent protection than companies in many other fields. *See* Cohen et al., *supra* note 17; Levin et al., *supra* note 14.

get broad claims issued because they believed there was more at stake.[80] Second, the pace of change in these industries is less than in some of the other industries we have studied, like software and semiconductors. Indeed, most pharmaceutical and biotechnological patents will not be useful until close to the end of their term, because the inventions covered by those patents must await FDA approval before they can be sold, and the FDA approval process is longer than the patent prosecution process in most cases. Thus, the price of abandonment and refiling—delay in the issuance of a patent[81]—may hurt those companies less than it would hurt companies in faster-moving industries.[82]

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.[83] 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, industries whose patents spend longer in prosecution than average may feel unfairly disadvantaged by the 20-year patent term.[84] The results of this analysis are presented in Table 10.

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, and automotive inventions.[85] On the other hand, patents in the areas of chemistry, pharmaceuticals, software, and biotechnology took significantly

80. Related to this argument is the theory that the PTO is harder on patent applications in these fields, necessitating a longer prosecution process that includes more continuation practice. *Cf.* Janice M. Mueller, *The Evolving Application of the Written Description Requirement to Biotechnological Inventions*, 13 BERKELEY TECH. L.J. 615 (1998) (making this argument in the written description context).

81. *See generally supra* notes 10-11 and accompanying text (discussing the relationship between time in prosecution and the number of filings).

82. Strictly speaking, this argument is true only of that subset of inventions in these categories that would require approval by the U.S. Food and Drug Administration ("FDA"). Nonetheless, that subset may be large enough te influence the numbers for the whole category.

83. *See generally* Lemley, *supra* note 8, at 369 (reviewing some of this controversy and discussing an earlier study of the phenomenon).

84. In response to these criticisms, in 1999 Congress 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.

85. Note that both tbe mechanical and electronics inventions are the more limited classes that we defined, *not* the broad classes defined by the PTO classification system.

longer than average to make it through the PTO.[86] In the case of both pharmaceuticals and biotechnology, the mean time in prosecution was well over four years.[87] These results are statistically significant.[88]

The policy implications of this finding are unclear. On the one hand, it might seem unfair to give less protection to some types of technology than to others. Thus, these data might be used to support an argument for differential protection for certain types of technology.[89] 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,[90] 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

86. This confirms and updates Johnson's conclusions that patents in the biotechnology industry in particular spent longer in prosecution tban otber types of patents. *See* Johnson, *supra* note 29, at figs. 8-10.

87. In all three cases, however, tbe standard deviation was significantly higber tban 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.

88. Using a Poisson regression, we obtained the following test results:

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
PHARM	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	6.120	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.

89. Some have suggested that the duration of patent protection should vary by industry te account for different economic facters in different fields. *But see* Louis Kaplow, *The Patent-Antitrust Intersection: A Reappraisal*, 97 HARV. L. REV. 1813 (1984) (providing skeptical discussion of this idea). The law does in fact permit such variation in the specific context of pharmaceuticals. *See* 35 U.S.C. §§ 155-56 (1994).

90. *See generally supra* text accompanying notes 83-88 (describing the relationship between area of technology and the number of applications filed); *infra* tbl. 9. It is clear from Table 9 that pbarmaceuticals and biotechnology, two of the areas with the longest pendency times, also have a disproportionately high number of refilings.

patent term.[91] 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. To determine size, we used data on the "small entity status" of the patent owner at the time of grant.[92] Thus, we divided each area of technology into patents filed by "small entities" and "large entities" as the PTO defines them.[93] Within the small entity category, we further subdivided patentees into three PTO categories: individuals, small businesses, and non-profit organizations. The results of these tests are reproduced in Table 11.

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: (1) individuals, who filed 17.5% of all the patents in the sample; (2) non-profits, which filed 1.1%; and (3) small businesses, which 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, including computer-related, software, semiconductors, chemistry, optics, automotive, and energy-related, small entities obtained less than 20% of the patents in the field. These results are statistically significant, both between large and small entities and across the range of each type of entity.[94]

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91. This results from the significant time such inventions normally spend in the FDA approval process.

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

93. *See supra* note 37.

94. We conducted a Chi-square test of homogeneity between areas of technology and each category and ohtained the following test results:

Small vs. Large

STATISTICS FOR TABLE OF ENTITY SIZE BY TECHNOLOGY FIELD

Statistic	DF	Value	Prob
ƒƒ			
Chi-Square	13	165.960	0.001

By each category

STATISTICS FOR TABLE OF ENTITY STATUS BY TECFIELD

Statistic	DF	Value	Prob
ƒƒ			
Chi-Square	39	194.743	0.001

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 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.[95] Since disputes between large and small inventors seem to drive patent policy of late, it is important to recognize that those different groups are often patenting different sorts of inventions.

A related issue is the relationship between area of technology and the number of inventors listed on any given patent.[96] We found only modest differences between the mean number of inventors in each area of technology. The data are presented in Table 12.

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, with the exception of mechanics, had 2 named inventors. These differences are statistically significant,[97] and they track to

We caution, however, that the test of each category may not be valid for categories with small sample sizes, notably non-profits.

95. It is conceivable 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.

96. It is reasonable to expect that patents acquired by large entities will list more co-inventors than patents by individuals or small businesses.

97. Using a Poisson regression, we obtained the following test results:

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
PHARM	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

some extent the size differentials just noted. Areas of technology that 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 are not that great.

We also tested the relationship between areas of technology and the number and type of prior art references cited in the patent. Citation of prior art is the best proxy we have in these data for the quality and thoroughness of a patent examination, so variance in the prior art cited by area may be indicative of variance in the quality of the patents that issue. The results are presented in Table 13.

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, however, were dramatic.[98] Semiconductor and electronics patents cited many fewer references than the mean, an average of 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.[99] These differences are also reflected in the median number of references cited: 8 for semiconductors and 9 for elec-

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AUTO	1	0.5717	0.4496
ENERGY	1	4.1933	0.0406
COMMUN	1	0.1105	0.7396

98. These differences are statistically significant. We used a Poisson regression to relate areas of technology to number of references cited and obtained tbe following test results:

Total references

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
PHARM	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

99. 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 tban other sorts of patents. Johnson, *supra* note 29, at fig. 12.

tronics 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 an average low of 4.59 for biotechnology patents and 6.06 for pharmaceutical patents, to a high of 19.44 for medical device patents.[100] 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,[101] the software industry actually cited relatively more non-patent prior art than in most other areas of technology. While we think this is an encouraging sign, it does not necessarily mean that the PTO is doing a good job of finding the relevant prior art in the software field. Many commentators have suggested that virtually all

100. 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. *See infra* tbl. 13.

101. *See* Ahronian, *supra* note 71.

the relevant art in the software industry is non-patent art.[102] If so, the fact that most prior art cited in software patents still consists of other patents may mean that the PTO isn't citing nearly *enough* non-patent prior art in this field.

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 for either the complexity of the subject matter or for the importance of the patent to the applicant. The results are presented in Table 14.

The average number of claims across all areas of technology is 14.87 total claims, 2.75 of which are independent claims and 12.12 of which are 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. The total variance is not particularly great, however.[103] Thus, either the number of claims is not a good predictor of importance or complexity, or there is no substantial variance in complexity between different areas of technology.[104] The pattern is similar for both independent and dependent claims.

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102. *See, e.g.*, MARK A. LEMLEY ET AL., SOFTWARE AND INTERNET LAW 333-34 (2000); Cohen, *supra* note 71, at 1177-80; Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CAL. L. REV. (forthcoming 2001).

103. Using a Poisson regression, we obtained the following test results:

Total claims

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
PHARM	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

104. We are intuitively inclined te credit the former explanation.

3. Relationships Between Country of Origin and the Prosecution Process

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 invention's country of 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.

First, we tested the relationship between country 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."[105] Here we evaluate whether use of this practice differs by nationality. We tested two sets of data: U.S. versus 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.

The data show substantial variance by country in the use of the abandonment and refiling procedure.[106] While only a minority of

105. *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 OFF. SOC'Y 11 (1999); Timothy R. DeWitt, *Does Supreme Court Precedent Sink Submarine Patents?*, 38 IDEA 601 (1998); Lomley, *supra* note 30, at 369; David L. Marcus, *Is the Submarine Patent Torpedoed?* Ford Motor Co. v. Lemelson *and the Revival of Continuation Application Laches*, 70 TEMP. L. REV. 521 (1997); James W. Morando & Christian H. Nadan, *Silent Enemies*, RECORDER, May 4, 1994, at 10.

106. Using a Poisson regression, we obtained the following test results:

Foreign vs. US

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	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	Chi-Square	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

patentees in every country tested used this procedure, 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. versus foreign patents and country-by-country results. The results are presented in Table 16.

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.[107] This result may seem at first glance

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107. These results are statistically significant for Foreign vs. U.S. We used a Gamma regression because one of the variables is continuous rather than discrete. Gamma regression is simply one of many forms of Generalized Linear Model; Poisson regression is another. Although Gamma is not the only method that could have been used for this test, we determined with our statistician that Gamma was a better fit for this subset of data because it provides an additional constraint to ensure that all of the data remain positive numbers.

The terms Poisson regression and Gamma regression are shorthand phrases for particular types of Generalized Linear Models. One builds the model and tben uses regression (here, logistic regression) to produce a result. *See* JAMES K. LINDSEY, APPLYING GENERALIZED LINEAR MODELS 18-25, 132-33 (George Casella et al. eds., 1997); PETER MCCULLAGH & JOHN A. NELDER, GENERALIZED LINEAR MODELS 287-322 (2d ed. 1989).

Test Result:

Foreign vs. US

LR Statistics For Type 3 Analysis

Source	**DF**	**Chi-Square**	**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**	**Chi-Square**	**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

to support the complaints of those who allege that the patent system is somehow stacked against U.S. inventors. We encourage caution in attempting to explain these results, however. As noted in the previous Section, time spent in prosecution may be dependent on other factors like the total number of applications filed. Thus, the fact that U.S. inventors refiled patent applications more often than any other country likely contributes to its high time in prosecution, and Taiwanese reluctance to engage in this practice may explain 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 technology observed earlier.[108] 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 data are presented in Table 17. The results are striking. There is tremendous variance by country in whether small entities obtain a significant portion of the patents in the sample.[109] U.S. patentees are more likely than foreign patentees to be small entities. Similarly, patentees in Taiwan, Australia, Switzerland, and Canada are more likely than average to be small entities while patentees in Japan, Korea, Germany, and France are unlikely to be

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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.

108. *See supra* notes 73-76 and accompanying text.

109. The results are statistically significant, though the country-by-country results must be interpreted with caution. We used a Chi-square test of homogeneity and obtained the following test results:

Foreign vs. US

STATISTICS FOR TABLE OF ORIGIN BY ENTITY SIZE

Statistic	F	Value	Prob
Chi-Square	3	71.664	0.001

Country-by-country

STATISTICS FOR TABLE OF COUNTRY BY ENTITY SIZE

Statistic	DF	Value	Prob
Chi-Square	33	227.327	0.001

Again, however, the small sample size renders the statistical significance of this second test suspect.

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.

This data might reflect cultural differences in innovation between the countries. For example, one could construct an argument that the U.S. economic climate is more hospitable than Japan to start-ups and independent inventors. However, we suspect a large part of the effect is attributable to the high cost of worldwide patent protection. Small entities presumably have less money to spend on patent prosecution. They may therefore be more likely to prosecute patents in their home country but not abroad than large entities with overseas sales and large prosecution budgets. If so, the large number of U.S.-based small entities may simply be an artifact of where the study was done.[110]

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

The results generally 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.[111] 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

110. An empirical test of this proposition could be conducted by measuring similar "small entity" filings in other countries, if the data could be found.

111. We used a Poisson regression. Tbe 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	Chi-Square	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	Chi-Square	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

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.

One exception to the general homogeneity of inventorship involves Japan. Japan has significantly more inventors per patent than any other country. One might look to cultural factors such as a tradition of collaboration or sharing of credit to explain this result.[112] Alternatively, it is worth noting that Japan had the lowest percentage of small entity patent owners, and that entity size is strongly correlated with the number of inventors per patent.[113]

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

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, with 19.29 per U.S. patent compared to 10.31 per foreign patent, and at the median, with 13 in the median U.S. patent compared to 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. This last fact gives us some inferential evidence that much of the prior art cited in patents is, in fact, art submitted by the applicant, not art found by the examiner. Applicants are more likely to have access to art from their home country; there is no reason to believe examiners would be more likely to find art from the applicant's home country.

To the extent that citation of a great deal of prior art is evidence of a more rigorous prosecution process, something the last paragraph calls into question, it appears that U.S. patents were subject to somewhat more searching inquiry than foreign patents. Again, however, we urge caution in interpreting this data. There is likely a connection between the sorts of technology patented in the U.S. and the prior art citation counts. Because the U.S. is disproportionately represented in pharmaceutical and biotechnological inventions, and because those inventions cite more prior art than average, it makes sense that U.S. inventions cite more art than their foreign counterparts.

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112. It is worth noting, however, that this supposed cultural characteristic does not hold true for the other Asian countries in the sample, Taiwan and Korea, which had significantly fewer inventors per patent than average.

113. *See infra* note 127 and accompanying text.

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.

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 even 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.[114]

114. Using a Poisson regression, we obtained the following test results:

Total Claims—

US vs. Foreign

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	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	Chi-Square	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	Chi-Square	Pr>Chi
ORIGIN	1	17.7774	0.0001

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

LR Statistics For Type 3 Analysis

To the extent that one can view claims as a proxy for the complexity of a patent application, a supposition we are skeptical of, these data would seem to suggest that U.S. patents were on average somewhat more complex than their foreign counterparts.

4. Relationships Among Prosecution Factors

Finally, we tested a number of relationships among what we refer to as "prosecution-related factors": 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.

Source	DF	Chi-Square	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	Chi-Square	Pr>Chi
ORIGIN	1	285.4291	0.0001

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

Source	DF	Chi-Square	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

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.

We found no significant relationship between entity size and the number of applications filed.[115] Thus, it does not appear that either large companies or small entities are more likely to abandon and refile their patents. This may have some implications for the ongoing dispute over "submarine patenting" and other efforts to take advantage of the patent system.

We also conducted statistical tests of the relationship between the total number of applications filed and the time spent in prosecution, as well as 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[116] and increased the number of references of all types cited in the patent.[117] Because these

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115. Using a Poisson regression, we obtained the following test results:
Small vs. Large
LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
ENTISIZE	1	0.5651	0.4522

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

Source	DF	Chi-Square	Pr>Chi
NPROFIT	1	0.1527	0.6960
SBIZ	1	0.4854	0.4860
LBIZ	1	0.0953	0.7576

116. Using a Poisson regression, we obtained the following test results:
LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
YPTO	1	295.3397	0.0001

117. Using a Poisson regression, we obtained the following test results:
Total references

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
TOTREF	1	52.3760	0.0001

US references

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
USPREF	1	30.2539	0.0001

Foreign references

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
FORPREF	1	19.8184	0.0001

Non references

LR Statistics For Type 3 Analysis

tests compare two continuous variables, we have not represented the data in a table.

Related to the test of total applications filed against time spent in prosecution is the question of how individual types of refilings affect time spent in prosecution. We divided patents into different categories depending on whether they filed 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.

These results are not very 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.[118] By contrast, patents with at least one U.S. refiling of any sort, continuation, CIP, or divisional, spent around five years on average in the prosecution process. The maximum time, at 18.15 years, was also much longer than for patents without any history of refiling. It is worth noting, however, that the patent in question was abandoned and refiled several times during that period.[119] Thus, time spent in prosecution seems to be a function of how many times the applicant goes back to the patent office with new arguments or amendments. This shouldn't surprise anyone. But it does suggest that at least some of the delay in prosecution is within the control of the patent applicant. Since Congress has just acted to try to limit delay caused by the PTO,[120] it seems important to note that the PTO is by no means the only source of delay in prosecution.

A curious 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

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Source	**DF**	**Chi-Square**	**Pr>Chi**
NPREF	1	26.7643	0.0001

118. 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 Inventors Protection Act will provide term extensions in many such cases. *See* 35 U.S.C. § 154(b) (1994).

119. 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. *See* 35 U.S.C. § 154(c)(1) (1994). Thus, those patents in this sample with long prosecution histories will not lose protection as a result of the time spent in prosecution.

120. *See id.* § 154(b).

not exclusively patents owned by foreign entities),[121] spent significantly longer in prosecution than patents that did not claim any priority to any application. This does not, however, mean that foreign patents spent longer in prosecution.[122] 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, 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., with 2.66 years on average, than patents overall, with 2.77 years on average.[123]

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, including small entity status, the number and type of prior art references cited, and the number and type of claims filed.[124]

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, whether individual, non-profit, or small business. The results are reported in Table 25.

The data reject the supposition advanced by some[125] that the PTO process is stacked against individuals and small entities, at least where time spent in prosecution is concerned. Instead, the evidence suggests that large entities spend more time in prosecution, with 2.83 years on average and a median of 2.28 years, than small entities, with 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. In-

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121. *See supra* text accompanying notes 52-53.

122. In fact, when we tested this relationship directly, the opposite was true: foreign patents issued more quickly than U.S. patents. *See infra* tbl. 24.

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

124. See *supra* notes 125-29 and accompanying text for a report of the relationship between time spent in prosecution and the number of applications filed.

125. *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).

deed, the median patent to an individual issued in less than two years. These differences by entity size are statistically significant—size matters.[126]

This difference cannot be explained by a greater tendency to abandon and refile; as noted above, large entities are no more likely to engage in continuation practice than small entities. It might be explained by differences in the nature or complexity of the technology patented by small and large entities.

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.

First, we tested the relationship between small entity status and the number of inventors listed on the patent. The results are reproduced in Table 26.

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, with 1.47 on average, than patents owned by small businesses, with 1.89 on average.[127]

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126. Using a Gamma regression, we obtained the following test results:
Small vs. Large

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
ENTISIZE	1	4.3483	0.0370

By each category (with individual as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
NPROFIT	1	4.4025	0.0359
SBIZ	1	0.0964	0.7561
LBIZ	1	3.5224	0.0605

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

Next, we tested the relationship between entity size and the number and type of prior art references cited. The results are reprinted in Table 27.

The results are significant and somewhat surprising.[128] Despite their greater resources, on average, large entities cite less prior art than small entities, with 14.31 total references compared

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128. We used a Poisson regression and obtained the following test result:

Total references—

Small vs. Large

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
ENTISIZE	1	112.1334	0.0001

By each category (with individual as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	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	Chi-Square	Pr>Chi
ENTISIZE	1	53.9645	0.0001

By each category (with individual as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	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	Chi-Square	Pr>Chi
ENTISIZE	1	75.1942	0.0001

By each category (with individual as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	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	Chi-Square	Pr>Chi
ENTISIZE	1	81.9384	0.0001

By each category (with individual as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
NPROFIT	1	401.7654	0.0001
SBIZ	1	215.8163	0.0001
LBIZ	1	27.7535	0.0001

to 17.21.[129] 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. Since large entities presumably have greater resources to devote to prosecution, one might expect them to find and disclose more prior art to the PTO. In fact, the opposite seems to be the case. One possible explanation is that large entities tend to have more sophisticated patent counsel than small entities, and that those sophisticated lawyers advise their clients not to do a prior art search. If true, this explanation is somewhat troubling. While there is no requirement in the law that a patent applicant search for prior art, this theory suggests that the no-search rule is benefiting those who could most easily afford a search, while smaller entities are taking disclosure more seriously.

By contrast, large entities are likely to cite significantly more *foreign* patent references than small entities, with 2.71 foreign patent references cited by large entities on average, compared with 1.80 for small entities. This difference could reflect 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. A more probable explanation is that a large entity is more likely to file its application in multiple countries and therefore have more foreign prior art cited against it by foreign examiners.[130]

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 28.

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 entities: individuals file fewer claims of each type than any other entity, and non-profits file the most claims.[131] Most, but not all, of the differences are statistically significant.[132]

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129. Because "cited prior art" is a combination of prior art cited by the applicant and art found by the patent office, the art in question was not necessarily cited by the applicant rather than 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, or 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.

130. 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* Molins PLC v. Textron, Inc., 48 F.3d 1172, 1179 (Fed. Cir. 1995).

131. The conclusion with respect to non-profits is suspect, however; only 11 of the 1,000 patents in the sample were filed by non-profits.

132. We used a Poisson regression and obtained the following test results:

Total claims—

Small vs. Large

V. CONCLUSIONS

There is a wealth of interesting results in this data, and we outlined some of the more interesting findings in the Introduction. One overarching fact about modern patents stands out to us, however. The U.S. patent prosecution system is not unitary. Rather, different entities experience very different sorts of patent prosecution. For example, chemical, pharmaceutical, and biotechnological patents spend much longer in prosecution than other types of patents. Chemical, medical, and biotechnological patents cite much more prior art than other patents, and are abandoned and refiled much more frequently. Similarly, individual inventors experience a prosecution process that is different in some respects than large companies, and foreign applicants have a different experience in prosecution than domestic applicants.

These differences suggest that it is unwise to think of prosecution as a whole when setting patent policy. Objections and pro-

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LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
ENTISIZE	1	14.0773	0.0002

By each category (with individual as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	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	Chi-Square	Pr>Chi
ENTISIZE	1	0.6590	0.4169

By each category (with individual as the baseline)

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
NPROFIT	1	5.9076	0.0151
SBIZ	1	30.9016	0.0001
LBIZ	1	16.6640	0.0001

Dependent claims—
Small vs. Large

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
ENTISIZE	1	20.6063	0.0001

By each category (witb individual as the baseline):

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr>Chi
NPROFIT	1	188.6882	0.0001
SBIZ	1	47.9340	0.0001
LBIZ	1	5.0115	0.0252

posals for reform that are tailored to the needs of one industry may not fit another well at all. Thus, those who would make generalizations about patent prosecution should take care to ensure that they do not merely project the experience of one type of client or industry onto the prosecution process as a whole.

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.

VI. APPENDIX

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

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

Table 3
Patents By Region

North America[133]	557
Pacific Rim[134]	271
Europe[135]	167
TOTAL	**995**

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

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

133. Includes the U.S. and Canada.
134. Includes Japan, Korea, Australia, Taiwan, Hong Kong, and Singapore.
135. Includes the U.K., Ireland, Germany, Austria, France, Italy, Switzerland, the Netherlands, Belgium, Sweden, Norway, Finland, Denmark, and tbe Czech Republic.

Table 6

Technology Divisions by Country of Origin[136]

	US	CA	JA	KO	AU	TW
Mech	223	10	45	7	3	17
Chem	162	4	55	3	1	2
Elec	155	3	112	15	2	5
Total	540	17	212	25	6	24

	UK	GE	FR	IT	SW	NE	TOTAL
Mech	8	26	10	5	5	5	364
Chem	7	26	11	4	1	2	278
Elec	4	14	10	4	2	5	331
Total	19	66	31	13	8	12	973

%	US	CA	JA	KO	AU	TW
Mech	41.30%	58.82%	21.23%	28.00%	50.00%	70.83%
Chem	30.00%	23.53%	25.94%	12.00%	16.67%	8.33%
Elec	28.70%	17.65%	52.83%	60.00%	33.33%	20.83%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

%	UK	GE	FR	IT	SW	NE
Mech	42.11%	39.39%	32.26%	38.46%	62.50%	41.67%
Chem	36.84%	39.39%	35.48%	30.77%	12.50%	16.67%
Elec	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%

136 For convenience, we have used two-letter country-code abbreviations in the tables in this paper. Those abbreviations are: US=United States; CA=Canada; JA=Japan; KO=Korea; AU=Australia; TW=Taiwan; UK=United Kingdom; GE=Germany; FR=France; IT=Italy; SW=Switzerland; NE=Netherlands. The totals in the last column do not total 1000 because we omitted from Table 6 countries that had fewer than five U.S. patonts in our sample.

Table 7

Areas of Technology by Country of Origin

	Pharm	Med Dev	Bio-Tech	Comp-Rel	Soft-ware	Semi-Cond	Elec
US	48	48	31	121	40	46	35
CA	2	0	0	3	1	0	3
JA	7	5	3	83	23	31	21
KO	0	1	0	9	1	6	2
AU	2	0	0	1	1	0	1
TW	0	0	0	2	1	1	2
UK	4	1	1	3	2	0	2
GE	3	1	0	10	1	2	7
FR	3	4	1	4	4	1	2
IT	2	0	1	2	0	2	1
SW	0	1	0	0	0	0	0
NE	1	1	0	2	2	1	0
Total (with 5+ patents)	72	62	37	240	76	90	76
Total (All)	78	64	37	242	76	93	77

	Chem	Mech	Acous	Optics	Auto-Rel	Ener-Rel	Comm-Rel	Total
US	105	194	11	51	31	14	25	800
CA	4	7	0	3	1	1	0	25
JA	40	31	7	53	24	4	11	343
KO	1	7	1	6	1	0	1	36
AU	2	2	0	1	1	0	0	11
TW	2	17	0	1	0	0	0	26
UK	5	8	1	3	2	1	0	33
GE	20	27	1	3	9	0	1	85
FR	11	11	1	0	2	2	3	49
IT	3	4	0	1	0	0	0	16
SW	1	6	0	1	1	0	0	10
NE	4	4	0	4	0	0	0	19
Total (with 5+ patents)	198	318	22	127	72	22	41	1453
Total (All)	207	329	22	128	72	24	41	1490

%	Pharm	Med Dev	Bio-Tech	Comp-Rel	Soft-ware	Semi-Cond	Elec	Chem
US	61.54%	75.00%	83.78%	50.00%	52.63%	49.46%	45.45%	50.72%
CA	2.56%	0.00%	0.00%	1.24%	1.32%	0.00%	3.90%	1.93%

JA	8.97%	7.81%	8.11%	34.30%	30.26%	33.33%	27.27%	19.32%
KO	0.00%	1.56%	0.00%	3.72%	1.32%	6.45%	2.60%	0.48%
AU	2.56%	0.00%	0.00%	0.41%	1.32%	0.00%	1.30%	0.97%
TW	0.00%	0.00%	0.00%	0.83%	1.32%	1.08%	2.60%	0.97%
UK	5.13%	1.56%	2.70%	1.24%	2.63%	0.00%	2.60%	2.42%
GE	3.85%	1.56%	0.00%	4.13%	1.32%	2.15%	9.09%	9.66%
FR	3.85%	6.25%	2.70%	1.65%	5.26%	1.08%	2.60%	5.31%
IT	2.56%	0.00%	2.70%	0.83%	0.00%	2.15%	1.30%	1.45%
SW	0.00%	1.56%	0.00%	0.00%	0.00%	0.00%	0.00%	0.48%
NE	1.28%	1.56%	0.00%	0.83%	2.63%	1.08%	0.00%	1.93%
Total (with 5+ patents)	92.31%	96.88%	100.00%	99.17%	100.00%	96.77%	98.70%	95.65%

%	Mech	Acous	Optics	Auto-Rel	Ener-Rel	Comm-Rel	% Total Pats
US	58.97%	50.00%	39.84%	43.06%	58.33%	60.98%	54.0%
CA	2.13%	0.00%	2.34%	1.39%	4.17%	0.00%	1.7%
JA	9.42%	31.82%	41.41%	33.33%	16.67%	26.83%	21.2
KO	2.13%	4.55%	4.69%	1.39%	0.00%	2.44%	2.5%
AU	0.61%	0.00%	0.78%	1.39%	0.00%	0.00%	0.6%
TW	5.17%	0.00%	0.78%	0.00%	0.00%	0.00%	2.4%
UK	2.43%	4.55%	2.34%	2.78%	4.17%	0.00%	1.9%
GE	8.21%	4.55%	2.34%	12.50%	0.00%	2.44%	6.6%
FR	3.34%	4.55%	0.00%	2.78%	8.33%	7.32%	3.1%
IT	1.22%	0.00%	0.78%	0.00%	0.00%	0.00%	1.3%
SW	1.82%	0.00%	0.78%	1.39%	0.00%	0.00%	0.8%
NE	1.22%	0.00%	3.13%	0.00%	0.00%	0.00%	1.2%
Total (with 5+ patents)	96.66%	100.00%	99.22%	100.00%	91.67%	100.00%	

Table 8

Areas of Technology by U.S. Origin

	US origin	non-US	Total
Pharm	48	30	78
Med Dev	48	16	64
BioTech	31	6	37
Comp-Rel	121	121	242
Software	40	36	76
SemiCond	46	47	93
Elec	35	42	77
Chem	105	102	207
Mech	194	135	329
Acoustics	11	11	22
Optics	51	77	128
Auto-Rel	31	41	72
Ener-Rel	14	10	24
Comm-Rel	25	16	41
Total	800	690	1490

%	US origin	non-US	Total
Pharm	61.54%	38.46%	100.00%
Med Dev	75.00%	25.00%	100.00%
BioTech	83.78%	16.22%	100.00%
Comp-Rel	50.00%	50.00%	100.00%
Software	52.63%	47.37%	100.00%
SemiCond	49.46%	50.54%	100.00%
Elec	45.45%	54.55%	100.00%
Chem	50.72%	49.28%	100.00%
Mech	58.97%	41.03%	100.00%
Acoustics	50.00%	50.00%	100.00%
Optics	39.84%	60.16%	100.00%
Auto-Rel	43.06%	56.94%	100.00%
Ener-Rel	58.33%	41.67%	100.00%
Comm-Rel	60.98%	39.02%	100.00%
Share of Total	54.00%	46.00%	100.00%

Table 9

Number of Applications Filed by Area of Technology

	Pharm	Med Dev	Bio-Tech	Comp-Rel	Soft-ware	Semi-Cond	Elec
Total # US apps Filed	177	98	88	357	109	131	97
Median	2	1	2	1	1	1	1
Mode	1	1	1	1	1	1	1
Std. Dev.	1.66	0.94	1.55	1.00	0.81	0.76	0.57
Max	7	5	6	8	5	4	3
Min	1	1	1	1	1	1	1
Average	2.27	1.53	2.38	1.48	1.43	1.41	1.26
Margin of Error +/-	0.19	0.12	0.26	0.06	0.09	0.08	0.06

	Chem	Mech	Acous	Optics	Auto-Rel	Ener-Rel	Comm-Rel
Total # US apps Filed	390	426	27	204	82	38	54
Median	1	1	1	1	1	1	1
Mode	1	1	1	1	1	1	1
Std Dev	1.36	0.72	0.61	1.10	0.39	1.14	0.65
Max	9	6	3	8	3	6	4
Min	1	0	1	1	1	1	1
Average	1.88	1.29	1.23	1.59	1.14	1.58	1.32
Margin of Error +/-	0.09	0.04	0.14	0.10	0.05	0.24	0.10

	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
Margin of Error +/-	0.04	0.08	0.05

Table 10

Time in Prosecution by Area of Technology

	Pharm	Med Dev	Bio-Tech	Comp-Rel	Soft-ware	Semi-Cond	Elec
Avg yrs in PTO	4.46	2.76	4.72	2.82	3.15	2.73	2.12
Median	3.24	2.33	3.91	2.42	2.78	2.33	1.86
Mode	#N/A	1.35	#N/A	1.82	1.82	1.35	1.57
Std Dev	2.95	1.41	2.71	1.56	1.58	1.48	0.94
Max	12.79	7.68	10.38	10.22	10.22	8.81	5.42
Min	1.02	1.01	0.71	0.82	1.07	1.10	0.67
Margin of Error +/-	0.33	0.18	0.45	0.10	0.18	0.15	0.11

	Chem	Mech	Acous	Optics	Auto-Rel	Ener-Rel	Comm-Rel
Avg yrs in PTO	3.52	2.27	2.66	2.81	2.20	2.74	2.64
Median	2.59	1.97	2.11	2.39	2.08	1.87	2.52
Mode	1.70	1.53	2.84	2.45	2.16	3.09	2.85
Std Dev	2.59	1.13	1.51	1.61	0.82	1.62	1.01
Max	18.15	8.52	6.21	8.81	4.89	8.11	6.11
Min	0.93	0.73	1.04	0.82	0.76	0.94	0.94
Margin of Error +/-	0.18	0.06	0.33	0.14	0.10	0.34	0.16

Table 11

Entity Size By Area of Technology

	Indiv	Sm 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
Semi-Cond	5	5	1	11	82	93
Elec	13	9	1	23	54	77
Chem	20	9	2	31	176	207
Mech	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
Ener-Rel	2	1	1	4	20	24
Comm-Rel	6	3	0	9	32	41
Total	234	152	18	404	1086	1490

	Indiv	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%
Elec	56.52%	39.13%	4.35%	100.00%
Chem	64.52%	29.03%	6.45%	100.00%
Mech	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%
Ener-Rel	50.00%	25.00%	25.00%	100.00%
Comm-Rel	66.67%	33.33%	0.00%	100.00%

	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%
Elec	29.87%	70.13%	100.00%
Chem	14.98%	85.02%	100.00%
Mech	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%
Comm-Rel	21.95%	78.05%	100.00%

Table 12

Number of Inventors by Area of Technology

	Pharm	Med Dev	Bio-Tech	Comp-Rel	Soft-ware	Semi-Cond	Elec
Avg # Inventors	2.81	2.33	2.84	2.28	2.42	2.13	2.48
Median	2	2	2	2	2	2	2
Mode	2	1	2	1	2	1	2
Std Dev	1.73	1.72	1.91	1.49	1.55	1.35	1.66
Max	9	10	11	10	10	7	10
Min	1	1	1	1	1	1	1
Margin of error +/-	0.19	0.21	0.32	0.09	0.18	0.14	0.19

	Chem	Mech	Acous	Optics	Auto-Rel	Ener-Rel	Comm-Rel
Avg # Inventors	2.85	1.77	1.86	2.57	2.07	2.79	2.27
Median	2	1	2	2	2	2	2
Mode	2	1	1	1	1	1	1
Std Dev	1.71	1.18	0.99	1.76	1.29	2.08	1.38
Max	10	9	4	10	7	9	7
Min	1	1	1	1	1	1	1
Margin of error +/-	0.12	0.06	0.22	0.15	0.15	0.44	0.22

Table 13

U.S. Patent References

	Pharm	Med Dev	Bio-Tech	Comp-Rel	Soft-ware	Semi-Cond	Elec
Avg # US pat ref	6.06	19.44	4.59	10.21	9.59	6.49	9.35
Median	3	12	2	7	7	5	7
Mode	0	5	0	6	5	2	4
Std Dev	10.14	22.60	7.40	11.43	12.90	5.20	11.32
Max	76	137	38	112	112	25	87
Min	0	0	0	0	1	0	0

	Chem	Mech	Acous	Optics	Auto-Rel	Ener-Rel	Comm-Rel
Avg # US pat ref	9.94	12.70	8.95	10.16	12.36	14.63	10.56
Median	6	8	7	7	8	10	6
Mode	3	6	4	5	7	10	6
Std Dev	12.44	14.33	5.98	14.19	13.88	16.94	14.50
Max	82	137	19	137	68	82	87
Min	0	0	1	0	0	1	1

Foreign Patent References

	Pharm	Med Dev	Bio-Tech	Comp-Rel	Soft-ware	Semi-Cond	Elec
Avg # For pat ref	2.60	2.84	2.97	1.77	1.26	1.57	1.66
Median	1	1	1	0	0	1	0
Mode	0	0	0	0	0	0	0
Std Dev	3.84	5.80	7.36	2.72	2.39	2.17	2.93
Max	24	36	43	16	12	10	18
Min	0	0	0	0	0	0	0
Margin of error +/-	0.43	0.72	1.23	0.17	0.27	0.22	0.33

	Chem	Mech	Acous	Optics	Auto-Rel	Ener-Rel	Comm-Rel
Avg # For pat ref	3.63	2.60	1.82	2.14	3.83	1.79	1.66
Median	2	1	0	1	2	2	0
Mode	0	0	0	0	0	0	0
Std Dev	4.62	4.21	3.53	3.09	4.83	1.98	3.40
Max	24	36	15	17	19	6	18
Min	0	0	0	0	0	0	0
Margin of error +/-	0.32	0.23	0.78	0.27	.57	.42	.54

Non-patent References

	Pharm	Med Dev	Bio-Tech	Comp-Rel	Soft-ware	Semi-Cond	Elec
Avg # non-pat ref	9.88	3.56	16.30	2.75	3.54	1.34	0.83
Median	5	0	15	0	1	0	0
Mode	0	0	7	0	0	0	0
Std Dev	12.60	10.55	12.68	7.56	7.33	3.03	2.32
Max	68	67	68	63	36	19	14
Min	0	0	1	0	0	0	0

	Chem	Mech	Acous	Optics	Auto-Rel	Ener-Rel	Comm-Rel
Avg # non-pat ref	3.43	0.53	2.45	2.72	0.63	0.75	2.41
Median	1	0	0	0	0	0	0
Mode	0	0	0	0	0	0	0
Std Dev	6.92	1.83	6.35	7.43	1.64	1.15	9.84
Max	55	19	30	67	8	3	63
Min	0	0	0	0	0	0	0

Total Prior Art References

	Pharm	Med Dev	Bio-Tech	Comp-Rel	Soft-ware	Semi-Cond	Elec
Avg # total art ref	18.55	25.84	23,86	14.74	14.39	9.41	11.84
Median	12	15	17	10	10	8	9
Mode	1	11	8	7	7	5	4
Std Dev	18.34	29.86	20.19	17.14	17.15	6.59	13.75
Max	83	163	93	137	137	30	105
Min	1	1	1	1	1	1	0

	Chem	Mech	Acous	Optics	Auto-Rel	Ener-Rel	Comm-Rel
Avg # total art ref	17.00	15.84	13.23	15.02	16.82	17.17	14.63
Median	11	11	10	10	10	14	8
Mode	8	5	19	7	7	25	6
Std Dev	17.11	16.75	11.72	18.53	16.50	17.76	23.05
Max	101	163	58	163	84	87	118
Min	1	0	1	1	1	1	1

Table 14
Total Claims

	Pharm	Med Dev	Bio-Tech	Comp-Rel	Soft-ware	Semi-Cond	Elec
Avg # total claims	14.99	17.05	13.30	16.02	17.11	15.83	15.47
Median	11	13	9	12	11	13	13
Mode	8	27	7	3	9	6	10
Std Dev	13.22	12.61	9.42	13.83	18.43	11.93	12.22
Max	82	61	36	120	120	64	57
Min	1	1	3	1	1	1	1
Margin of error +/-	1.49	1.58	1.57	0.88	2.11	1.23	1.39

	Chem	Mech	Acous	Optics	Auto-Rel	Ener-Rel	Comm-Rel
Avg # total claims	15.19	13.36	18.64	16.13	14.89	15.63	16.24
Median	14	11	17	14	13	13	12
Mode	15	10	16	20	10	10	9
Std Dev	10.67	9.45	9.52	14.21	10.04	9.25	12.91
Max	82	55	43	120	55	40	49
Min	1	1	6	1	2	3	1
Margin of error +/-	0.73	0.51	2.11	1.24	1.18	1.95	2.04

Independent Claims

	Pharm	Med Dev	Bio-Tech	Comp-Rel	Soft-ware	Semi-Cond	Elec
Avg # ind claims	2.86	3.31	3.30	3.27	3.53	3.03	2.56
Median	2	3	3	3	3	3	2
Mode	1	3	2	1	2	1	1
Std Dev	2.20	3.08	2.36	2.54	2.75	2.21	1.59
Max	11	17	10	17	16	11	8
Min	1	1	1	1	1	1	1

	Chem	Mech	Acous	Optics	Auto-Rel	Ener-Rel	Comm-Rel
Avg # ind claims	2.22	2.56	3.59	2.95	2.75	3.88	3.44
Median	2	2	4	2	3	3	2
Mode	1	1	1	2	3	3	2
Std Dev	1.63	2.30	2.28	2.15	1.63	4.79	2.94
Max	11	24	10	16	8	24	14
Min	1	1	1	1	1	1	1

Dependent Claims

	Pharm	Med Dev	Bio-Tech	Comp-Rel	Soft-ware	Semi-Cond	Elec
Avg # dep claims	12.13	13.73	10.00	12.75	13.58	12.80	12.91
Median	8	12	6	10	9	10	10
Mode	7	8	4	2	10	8	2
Std Dev	12.75	10.81	8.76	12.49	17.11	10.86	11.50
Max	80	44	34	115	115	55	51
Min	0	0	0	0	0	0	0

	Chem	Mech	Acous	Optics	Auto-Rel	Ener-Rel	Comm-Rel
Avg # dep claims	12.97	10.80	15.05	13.18	12.13	11.75	12.80
Median	11	9	15	11	11	10	9
Mode	14	7	16	2	2	12	5
Std Dev	10.19	8.43	8.07	13.50	9.45	9.01	10.77
Max	80	47	33	115	47	37	38
Min	0	0	2	0	0	2	0

Table 15

Number of Applications Filed by Country of Origin

	US	CA	JA	KO	AU	TW
Total # US apps filed	865	27	317	32	7	24
Median	1	1	1	1	1	1
Mode	1	1	1	1	1	1
Std Dev	1.12	1.18	0.95	0.54	0.41	0
Max	9	5	8	3	2	1
Min	1	1	1	1	1	1
Mean	1.60	1.59	1.50	1.28	1.17	1.00
Margin of Error +/-	0.30		0.06	0.11	0.21	0.00

	UK	GE	FR	IT	SW	NE
Total # US apps filed	29	76	47	18	8	16
Median	1	1	1	1	1	1
Mode	1	1	1	1	1	1
Std Dev	1.02	0.53	1.03	0.96	0	0.89
Max	5	4	5	4	1	4
Min	1	0	1	1	1	1
Mean	1.53	1.15	1.52	1.38	1.00	1.33
Margin of Error +/-	0.25	0.07	0.19	0.29	0.00	0.28

Table 16

Time Spent in Prosecution by Country of Origin

	US	CA	JA	KO	AU	TW
Avg yrs in PTO	2.92	2.98	2.76	2.29	3.57	1.32
Median	2.33	2.10	2.37	2.13	1.95	1.30
Mode	1.35	#N/A	1.46	#N/A	#N/A	1.27
Std Dev	1.99	2.16	1.45	0.93	4.00	0.35
Max	18.15	9.70	8.96	4.77	11.67	2.19
Min	0.69	1.51	0.94	1.13	1.47	0.67
Margin of Error +/-	0.08	0.55	0.10	0.19	2.10	0.07

	UK	GE	FR	IT	SW	NE
Avg yrs in PTO	3.50	2.37	2.65	2.71	1.83	2.40
Median	2.37	2.15	2.32	2.12	1.94	1.86
Mode	#N/A	1.63	2.85	#N/A	1.95	#N/A
Std Dev	2.82	1.36	1.32	1.54	0.53	1.74
Max	12.79	10.22	6.20	6.45	2.54	7.34
Min	1.28	0.82	1.01	1.22	1.18	1.03
Margin of Error +/-	0.68	0.17	0.24	0.46	0.22	0.55

	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
Margin of Error +/-	0.08	0.07

Table 17

Small Entity Status by Country of Origin

	Small Entities	% of National Total
US	217	40.19%
CA	10	58.82%
JA	7	3.30%
KO	3	12.00%
AU	4	66.67%
TW	20	83.33%
UK	5	26.32%
GE	5	7.58%
FR	4	12.90%
IT	4	30.77%
SW	5	62.50%
NE	2	16.67%

Table 18

Number of Inventors by Country of Origin

	US	CA	JA	KO	AU	TW	UK	GE	FR	IT	SW	NE
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

	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

Table 19

U.S. Patent References

	US	CA	JA	KO	AU	TW
Avg # US pat ref	13.85	9.82	6.09	5.68	3.83	5.63
Median	9	7	5	5	5	6
Mode	7	5	4	3	5	6
Std Dev	15.21	8.42	4.27	3.66	1.94	3.21
Max	137	29	29	14	6	13
Min	0	0	0	1	1	0

	UK	GE	FR	IT	SW	NE
Avg # US pat ref	6.21	6.21	5.48	5.00	5.50	6.17
Median	5	6	5	4	5	5
Mode	1	6	2	4	2	5
Std Dev	5.45	5.39	4.03	3.74	3.55	4.09
Max	18	37	15	14	12	15
Min	0	0	0	0	2	1

Foreign Patent References

	US	CA	JA	KO	AU	TW
Avg # for pat ref	2.03	1.76	3.03	0.52	3.83	0.33
Median	0	0	2	0	2	0
Mode	0	0	0	0	1	0
Std Dev	4.24	3.19	3.46	0.82	4.17	0.76
Max	43	11	18	3	10	3
Min	0	0	0	0	0	0

	UK	GE	FR	IT	SW	NE
Avg # For pat ref	4.95	4.33	2.94	2.54	2.88	2.92
Median	4	4	2	2	3	3
Mode	0	4	0	0	2	3
Std Dev	5.73	4.45	3.00	2.50	2.42	2.57
Max	24	26	12	7	7	7
Min	0	0	0	0	0	0

Non-Patent References

	US	CA	JA	KO	AU	TW
Avg # non-pat ref	3.41	0.65	1.16	0.20	9.17	0.13
Median	0	0	0	0	0	0
Mode	0	0	0	0	0	0
Std Dev	8.19	1.11	2.50	1.00	22.45	0.34
Max	68	4	19	5	55	1
Min	0	0	0	0	0	0

	UK	GE	FR	IT	SW	NE
Avg # non-pat ref	2.79	0.79	1.06	1.38	0.63	1.67
Median	0	0	0	1	0	1
Mode	0	0	0	0	0	0
Std Dev	5.84	1.40	2.22	1.80	1.06	3.39
Max	19	8	10	5	3	12
Min	0	0	0	0	0	0

Total Prior Art References

	US	CA	JA	KO	AU	TW
Avg # total pat ref	19.29	12.24	10.28	6.40	16.83	6.08
Median	13	7	9	5	6	6
Mode	7	2	7	5	6	5
Std Dev	20.07	11.24	6.58	4.04	26.09	3.51
Max	163	37	47	15	70	16
Min	0	1	1	1	5	2

	UK	GE.	FR	IT	SW	NE
Avg # total pat ref	13.95	11.33	9.48	8.92	9.00	10.75
Median	12	10	9	7	7	9
Mode	1	10	14	7	6	8
Std Dev	12.31	8.59	5.03	5.01	4.34	7.89
Max	49	64	22	20	16	30
Min	1	1	1	4	5	2

Table 20

Number and Type of Prior Art References by Country of Origin

	US	Non-US
Avg # US pat ref	13.85	6.23
Median	9	5
Mode	7	5
Std Dev	15.21	4.86
Max	137	37
Min	0	0

	US	Non-US
Avg # for pat ref	2.03	2.93
Median	0	2
Mode	0	0
Std Dev	4.24	3.58
Max	43	26
Min	0	0

	US	Non-US
Avg # non-pat ref	3.41	1.16
Median	0	0
Mode	0	0
Std Dev	8.19	3.49
Max	68	55
Min	0	0

	US	Non-US
Avg # total pat ref	19.29	10.31
Median	13	9
Mode	7	7
Std Dev	20.07	7.82
Max	163	70
Min	0	1

Table 21

Number and Type of Claims by Country of Origin

Independent Claims

	US	CA	JA	KO	AU	TW
Avg # ind claims	2.95	2.53	2.93	2.88	4.17	1.21
Median	2	3	2	2	3	1
Mode	1	3	1	2	3	1
Std Dev	2.31	1.12	2.44	2.52	3.43	0.66
Max	24	4	16	11	11	4
Min	1	1	1	1	2	1

	UK	GE	FR	IT	SW	NE
Avg # ind claims	2.21	1.98	2.23	2.23	1.38	2.25
Median	2	2	2	2	1	2
Mode	1	1	1	1	1	1
Std Dev	1.32	1.41	1.56	1.54	0.74	1.71
Max	5	7	7	5	3	6
Min	1	1	1	1	1	1

Dependent Claims

	US	CA	JA	KO	AU	TW
Avg # dep claims	13.82	13.76	9.91	7.60	11.67	2.83
Median	12	12	8	5	13	2
Mode	5	8	4	3	11	0
Std Dev	11.66	8.87	9.23	8.84	6.44	2.96
Max	115	38	51	44	19	11
Min	0	0	0	0	0	0

	UK	GE	FR	IT	SW	NE
Avg # dep claims	12.05	10.09	12.06	11.69	12.63	13.75
Median	12	9	11	8	11	13
Mode	17	7	0	4	#N/A	18
Std Dev	5.89	6.93	8.37	11.14	10.03	8.32
Max	26	29	34	45	26	28
Min	2	0	0	4	0	1

Total Claims

	US	CA	JA	KO	AU	TW
Avg # total claims	16.78	16.29	12.83	10.48	15.83	4.04
Median	14	14	10	8	17	3
Mode	20	10	6	4	17	2
Std Dev	12.65	8.84	10.41	10.48	7.28	2.96
Max	120	41	57	52	23	12
Min	1	1	1	2	3	1

	UK	GE	FR	IT	SW	NE
Avg # total claims	14.26	12.09	14.29	13.92	14.00	16.00
Median	14	11	13	10	12	15
Mode	19	14	10	10	#N/A	#N/A
Std Dev	6.45	7.40	8.31	11.84	10.36	9.14
Max	30	35	37	50	29	32
Min	3	2	1	5	1	4

Table 22

Number and Type of Claims by Country of Origin

	US	Non-US
Avg # ind claims	2.95	2.52
Median	2	2
Mode	1	1
Std Dev	2.31	2.08
Max	24	16
Min	1	1

	US	Non-US
Avg # dep claims	13.82	10.12
Median	12	8
Mode	5	2
Std Dev	11.66	8.56
Max	115	51
Min	0	0

	US	Non-US
Avg # total claims	16.78	12.64
Median	14	10
Mode	20	10
Std Dev	12.65	9.43
Max	120	57
Min	1	1

Table 23

Number of Applications Filed by Small Entity Status

	Sm Ent	Lg Ent
Total # US apps filed	426	1073
Median	1	1
Mode	1	1
Std Dev	1.02	1.01
Max	9	8
Min	1	1
Avg	1.45	1.52

Table 24

Time in Prosecution by Nature of Prior Application Filed

	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

Table 25
Time in Prosecution by Entity Size

	Indiv	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

Table 26
Number of Inventors by Entity Size

	Indiv	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

Table 27
Prior Art References by Entity Size

U.S. Patent References

	Indiv	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

	Indiv	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

	Indiv	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

	Indiv	Sm 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
Margin of Error +/-	1.20	1.76	6.33	0.98	0.59

Table 28

Number and Type of Claims by Entity Size

Independent Claims

	Indiv	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

	Indiv	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

	Indiv	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