WHERE'S THE INNOVATION?
AN ANALYSIS OF THE QUANTITY AND QUALITIES OF
ANTICIPATED AND OBVIOUS PATENTS

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ABSTRACT

While the main theoretical benefit of patent protection is increased innovation, some assert a swamped U.S. Patent and Trademark Office has granted an inefficiently large number of patents with negligible innovation value. I test this argument's plausibility and determine the characteristics of patents without innovation by analyzing 980 litigated patents subject to anticipation or obviousness decisions between 2000 and 2010. Using a selection corrected probit model, I obtain unconditional estimates of the likelihood patents with given characteristics lack innovation value. I estimate a surprising 28 percent of all patents would be found at least partially invalid if litigated. Software, business method and licensing firm-owned patents possess significantly higher innovation-based invalidity rates.

1. INTRODUCTION

Increased innovation is the main theoretical economic benefit of patent protection. (Bessen and Maskin 2009) Of course, we do not enjoy this benefit free. Our patent system includes a costly application process through the U.S. Patent and Trademark Office (PTO) and costly method of deciding unresolved patent disputes through federal litigation. These social costs of maintaining our system have greatly increased in recent decades as both the number of patent applications and filed patent lawsuits have tripled since the early 1980s (Jaffe and Lerner 2004; Bessen and Meuer, 2005b).

Many of the arguments of economists and legal scholars critical of the health of the patent system boil down to the idea these burgeoning costs have not been matched by increases in the innovation benefit. Jaffe and Lerner (2004), in particular, argue an increasingly swamped PTO has granted many patents with negligible innovation benefit, particularly those covering technologies only recently patented on a large scale. These include biotechnology, software and business method patents.

Further, opportunistic litigation by licensing firms may disproportionally add to increased costs because the more uncertain scope of software and methods makes these patents ideal tools to extract rents from independently inventing producers in "hold up" litigation. (Bessen and Meuer 2008) The evidence for these arguments remains limited. However, an analysis of judicial decisions on the invalidity defenses of anticipation and obviousness can assist in determining their credibility.

Anticipated patents are legally invalid because they cover old ideas, which are not innovative by definition. Obvious patents are invalid because a professional in the same field would have known how to solve the problem the invention is directed at in the same way. While an obvious solution is new in the sense the "inventor" was the first to employ the solution, it generated no new knowledge. Thus, whether judged obvious or anticipated, the implication is the patented ideas have negligible value as innovation so that resources used to obtain and enforce that patent were wasted.

Despite this extreme implication, we know little about anticipation or obviousness decisions. In this paper I remedy that gap in our knowledge by analyzing the characteristics of 980 patents subject to final anticipation or obviousness decisions in 579 cases filed between 2000 and 2010. To account for

selection effects and adjudicator bias, I control for many characteristics of the parties and adjudication and utilize a selection corrected probit model. I thus obtain unconditional estimates of the likelihood a patent with a given characteristic will be found to lack innovation value.

My results suggest the idea that the patent system's efficiency is harmed by the existence of too many non-innovative patents is quite plausible. I estimate <u>28 percent of patents would be found at least partially invalid</u> if subject to an anticipation or obviousness decision. Patents covering software and business methods, the subject to frequent criticism, have unconditional invalidity rates of 39 and 56 percent. The rate for licensing firm owned patents is 61 percent. In contrast, energy, medical and semiconductor patents have lower than average and biotechnology patents average invalidity rates.

Other results inform our understanding of open patent law and economics issues. Regarding patent value, I find patents with more claims or citations are not significantly more or less likely to be invalidated on innovation based grounds. Concerning the rationality of litigious patent owners and in contrast to Allison, Lemley, and Walker (2011), I find patents asserted in more cases are less likely to be invalidated. Concerning bias, I find several District Courts have significantly different invalidity rates and that the Federal Circuit is more likely than trial courts to find innovation-based invalidity.

In Part 2 of this paper I explain anticipation and obviousness, their connection to innovation value, and why the PTO may regularly grant patents lacking innovation value. Part 3 describes my analysis, Part 4 reports my results and Part 5 explains them.

2.   INNOVATION-BASED PATENT INVALIDITY

I begin by briefly describing the U.S. system of obtaining and enforcing patents, the courts' role in enforcing requirements for patentability and the law of anticipation and obviousness.

2.1. The Patent Office, the Courts, and Invalidity Defenses

In the United States, inventors apply for patents from the PTO. The heart of a patent application is one or more "claims" that specifically define what ideas the patent will protect. The basic requirements for the ideas expressed in the claims to be legally patentable are that they cover patentable subject matter,

are new and useful, and non-obvious. (35 USC §§ 101, 103) If the inventor demonstrates to the PTO that all requirements are met, the PTO grants the patent.

Once obtained, the patent provides its owner the right to exclude others from making, using, offering to sell, or selling the invention described in the claims. (35 USC § 271) Parties violating the owner's exclusive rights are liable for infringement, and may be sued for damages and injunctive relief. (35 USC § 271) While there is a legal presumption that PTO-granted patents are valid, meaning they meet all patentability requirements, invalidity is a defense to patent infringement and an alleged infringer may overcome the presumption and demonstrate the patent is invalid with "clear and convincing evidence." (*Microsoft Corporation v. i4i Limited Partnership, et. al.*, 131 S. Ct. 2238 (2011))

Patent litigation in the United States is exclusively federal and all lawsuits must be filed in a federal district court. Since 1982, the Federal Circuit Court of Appeals (CAFC) has had exclusive jurisdiction over appeals of patent cases.

2.2. Anticipation and Obviousness

Anticipation and obviousness are invalidity defenses directly related to two of the basic patentability requirements. Alleged infringers attack the novelty of a patent by alleging anticipation and its non-obviousness by alleging obviousness. Validity is determined on a claim-by-claim basis so that all, part, or none of a patent may be found invalid in patent litigation. Whether a claim is anticipated or obvious is mainly determined by comparing the ideas contained in the claim to the "prior art". Prior art includes all public knowledge at the time of invention related to an invention.

CAFC precedent makes clear the legal distinction between anticipation and obviousness. "Anticipation requires the presence in a single prior art disclosure of all elements of a claimed invention arranged as in the claim." (*Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542, 1548 (Fed. Cir. 1983)) Obviousness, in contrast, may be based on multiple prior art references:

> Determining obviousness requires considering whether two or more pieces of prior art could be combined, or a single piece of prior art could be modified, to produce the claimed invention. This analysis typically invokes the familiar teaching-suggestion-motivation ("TSM") test, asking whether a person having ordinary skill in the art would have found some teaching, suggestion, or motivation to combine or modify the prior art references.

(*Comaper v. Best Buy*, 596 F.3d 1343, 1352 (Fed. Cir. 2010)) The legal connection between anticipation and obviousness is apparent—the ideas described in anticipated claims where already contained in a <u>single</u> earlier work, while obvious claims were partially described in earlier works and it was "obvious" to combine or modify them to obtain the full content of the claim.

2.3. Anticipation, Obviousness, and Innovation Value

Jaffe and Lerner (2004) explain the clear connection between innovation value as the main justification for patent protection and the invalidity defenses of anticipation and obviousness.[1] They argue the U.S. patent system is "broken" in large part because institutional and legal changes have resulted in the PTO granting too many patents with negligible innovation value.

> They begin by explaining the fundamental economic justification for patent protection:
>
> If there were no incentives for those who discover and develop new technology, it is likely that fewer innovations would be developed, slowing progress and the benefits it brings. Potential inventors realize that without adequate protection rivals will rapidly copy their discoveries, and that therefore innovation is at best an uncertain route to future profits. As a result, companies would be unlikely to spend significant amounts of money on Research and Development that is the source of new products and processes in a modern economy.

(Jaffe and Lerner 2004) Thus, patent protection benefits society when it increases innovation. Jaffe and Lerner (2004) continue by explaining that for the system to be effective in furthering this goal:

> [T]he party who is the first to invent a given product or process is the party that is awarded a patent. This analytical construct is embodied in patent law within the idea that a patent cannot be granted unless the patent application is for an invention that is both 'novel' and 'non-obvious'.

(Jaffe and Lerner 2004) Anticipated and obvious patents are thus invalid because the party who obtained the patent was not the inventor of the ideas the patents contain.[2]

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[1] Note, however, there are other possible economic justifications for patent protection. For example, some argue the patent system also lowers transaction costs and facilitates trade (see, for example, Kieff 2001).

[2] That patent laws exist to ensure the economic justification for patent protection is not surprising given the Constitution's explicit reason to grant patent rights—"[T]o promote the progress of . . . the useful Arts." U.S. Const., art. 1, § 8, cl. 8. The Supreme Court confirmed this justification in *Graham v. John Deere Co.*, 383 U.S. 1, 9 (1966), stating: "The patent monopoly was not designed to secure to the inventor his natural right in his discoveries. Rather, it was a reward, an inducement, to bring forth new knowledge." Further, in *Mazer v. Stein*, 347 U.S. 201, 219 (1954), the Court explained: "The economic philosophy behind the clause empowering Congress to grant

Innovation is knowledge production but anticipated or obvious patents contain no new knowledge. Thus, such patents lack innovation value. Accordingly, the existence of these invalidity defenses ensures the enjoyment of the exclusive rights that patents protect is connected to the rationale for that protection—to incent innovation. Unfortunately, before a court can determine that a patent lacks innovation it and alleged infringers must expend significant resources in litigation.[3] Thus, as measured after adjudication, the existence of these patents is a net social loss.

2.4. How Rare Are Patents that Lack Innovation Value?

If the PTO is empowered to screen applications that lack the legal requirements, we may wonder how frequently patents are granted on old or obvious ideas. According to many observers the answer is often.[4] Jaffe and Lerner (2004) argue the PTO has granted many patents of dubious innovation value for several reasons. First, the number of applications tripled between 1983 and 2002, swamping the PTO's examination resources. Second, after the early 1990s, the PTO was no longer tax-payer-funded but instead operated on the basis of increased patent application fees. This change created incentives for the PTO to quickly process applications and to be perceived as applicant friendly. (Jaffe and Lerner 2004)

The third reason Jaffe and Lerner (2004) offer pertains to technologies only recently patented on a large scale—namely software, business methods and biotechnology.[5] Jaffe and Lerner (2004) argue that

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patents and copyrights is the conviction that encouragement of individual effort by personal gain is the best way to advance public welfare."

[3] Bessen and Meurer (2008, p. 169) calculate the average cost, in legal fees alone, for a patent case to be litigated through summary judgment as $500,000 and the cost through trial as $4,000,000.

[4] Mandel (2006), *citing*: Fed. Trade Comm'n (2003), ch. 4, at 8-19 (criticizing a low standard for application of the non-obvious requirement and citing the testimony of many patent and economic scholars for the same); National Research Council (2004), at 87-95 (criticizing lenient non-obvious standards, particularly for business method and biotechnology patents); Shapiro (2004), at 1018 (noting that complaints regarding the PTO "typically allege that the [PTO] issues many questionable patents" including those that were "obvious at the time the patent application was filed"); Barton (2003), at 477-78 (arguing that the non-obvious standard applied by the PTO and courts today is not as strict as that articulated by the Supreme Court in *Graham*); Parker (2002), at 305-07 (arguing that the PTO has recently granted a number of obvious patents)); Thomas (2001) (discussing problems at the PTO in conducting non-obvious analyses); Merges (1999), at 598 (noting that "[t]he easiest way to raise standards [at the PTO], conceptually, is to tighten the nonobviousness requirement"); and Lemley and O'Brien (1997) at 301 (criticizing PTO leniency in issuing obvious patents in software.

[5] Already recognized as patentable to an extent, CAFC opinions during the 1990s broadened patentable subject matter in these areas. See *In re Alappat*, 33 F.3d 1526 (Fed. Cir. 1994) (software); *In re Deuel*, 51 F.3d 1552 (Fed. Cir. 1995) (biotechnology); and *State St. Bank & Trust Co. v. Signature Fin. Group*, 149 F.3d 1368 (Fed. Cir. 1998) (business methods).

when patenting of these subjects increased in the 1990s the PTO lacked examiners knowledgeable in these fields to thoroughly review the prior art. Perhaps more critical, examiners may have frequently missed the relevant prior art because of their overreliance on older patents in their prior art searches. Since these technologies were rarely patented before, the existing art was described in other sources, including professional journals and pre-existing product descriptions. (Jaffe and Lerner, 2004) Thus, there are plausible reasons to believe that during the last two decades the PTO has frequently granted patents on old or obvious ideas.

Existing data on anticipation and obviousness litigation decisions supports this conclusion. Allison and Lemley (1998) analyzed 299 validity decisions in 239 cases reported in the U.S.P.Q. from early 1989 to 1996. Of 191 invalidity determinations, 95 (or 50 percent) where based on anticipation or obviousness.[6] Thus, when alleged infringers challenge validity, they are most likely to do so on innovation-based grounds. Furthermore, alleged infringers frequently win. Allison and Lemley (1998) report 41 percent of anticipation and 33 percent of obviousness decisions found invalidity. This suggests it is not rare for courts to conclude the PTO mistakenly granted patents on old or obvious ideas.

Evidence that certain types of patents are more likely to be old or obvious is scant. Allison, Lemley, and Walker (2011) analyzed the litigation success of 106 "most-litigated" patents asserted in eight or more lawsuits between 2000 and 2008. They compared their success to a matched sample of patents litigated once. They found that patents in both their "most litigated" or "once litigated" samples were more likely to be invalidated if they were non-practicing entity (NPE) owned or covered software— precisely one of the technologies Jaffe and Lerner (2004) argue the PTO has had difficulty examining.

Allison, Lemley, and Walker (2011) found 60 of the 86 patents that lost in court were invalidated. While obviousness was not one of the three most common bases for the invalidation, anticipation was second. They did not report the basis on which each of the 60 patents was invalidated, but we can deduce a large percentage of the invalidated patents in their sample were invalidated on innovation based

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[6] Individually, 58 of 191 (42.0 percent) of invalidity determinations were based on obviousness and 37 (26.8 percent) on anticipation. The other common grounds were § 102-non-prior-art (31.2 percent), enablement or written description (15.2 percent), and best mode (11.6 percent). Many invalidity determinations were on multiple grounds.

grounds, were owned by NPEs, covered software and were asserted in many different lawsuits. Thus, the empirical evidence that exists suggests innovation-based invalidity is frequently litigated and found by courts despite the fact the PTO is tasked with rejecting applications on old or obvious ideas.

3. STUDY DESIGN

Having explained how anticipation and obviousness support the goal of patent protection and why these defenses may be increasingly necessary in a system where the PTO frequently grants patents on old or obvious ideas, I now describe my data and analytical method.

3.1. Data

Many factors may influence whether a patent is invalidated for anticipation or obviousness. Referencing Marco's (2004) analysis of patent litigation outcomes, I model the validity decision as a function of the characteristics of the asserted **patents**, the **parties**, and **adjudication**.

I used two main data sources to create my sample of final innovation–based invalidity decisions. The first was the Stanford IP Litigation Clearinghouse (IPLC), which details every patent lawsuit filed in the U.S. from 2000 to the present.[7] In the IPLC I identified 980 patents that faced a final decision on anticipation and/or obviousness in 579 lawsuits filed between 2000 and 2010.[8] My unit of analysis is a patent-case pairing, such that my sample includes multiple data points where innovation-based invalidity was decided for multiple patents in a single lawsuit.

By final decision, I mean that the adjudications in my sample were either decided by CAFC on appeal, were immediately appealable, or were grants of summary judgment that a patent was not invalid for anticipation or obviousness after which the case terminated without appeal. Thus, my data set includes invalidity determinations by the CAFC, by the trial court on JNOV, bench trial or grant of summary judgment, and by jury trial. It does not include denials of summary judgment, which merely hold disputed facts remain to be tried to determine whether or not a patent is invalid. (F.R.C.P. Rule 56)

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[7] For each patent lawsuit filed, the IPLC database includes a separate webpage with summary data and a list of all docket entries. Keyword searches may be run of all of these web pages and the content of their docket entries.

[8] To identify lawsuits with anticipation or obviousness decisions I searched the IPLC for keywords, including: "anticipate", "anticipation", "obvious", and "obviousness".

For each patent-case pairing, I gathered adjudication and party information from the IPLC and internet searches of the litigants. To identify the characteristics of the patents in my sample, I utilized the 2006 NBER U.S. Patent Citations data file (NBER data file) as my second primary source of data. The NBER data file contains detailed information on over three million U.S. patents granted through 2006.[9]

3.2. Analytical Method in Light of Adjudicator Bias and Selection Effects

I aim to infer the types of patents more or less likely to lack innovation value. A simple probit regression model would appear appropriate, but two key biases cast doubt on this strategy. The first, adjudicator bias, appears easy to control for by considering whether a judge, jury or appeals court makes the decision and in which district court. It seems unlikely all would err in the same direction but Mandel (2006) reports compelling evidence from experiments on mock jurors that the non-obviousness requirement is uniformly applied too stringently due to "hindsight bias."[10] Most scholars, however, believe the courts are biased towards validating obvious patents.[11] I adopt this view cautiously, and account for adjudicator bias with comprehensive adjudication controls.

Controlling for selection effects, the second bias, is not as simple. Selection effects refer to the process of parties choosing disputes for trial as opposed to settlement. Priest and Klein (1984) created the first formal model of this process which predicts both the rate at which disputes will be tried and the plaintiff's win rate at trial. (Siegelman and Waldfogel 1999) In the basic model these rates depend on the: 1) Decision standard; 2) Amount of uncertainty; and 3) Degree of stake asymmetry. (Siegelman and Waldfogel 1999) Later models predict other factors influence the plaintiff win rate, including asymmetric information, rent seeking, entry deterrence, or differences in risk aversion. (Cooter and Rubinfeld 1989)

These factors influence plaintiff win rates and confound inferences about the population of potential disputes (in my case all patents) from the set of disputes selected for adjudication (in my case

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[9] As a check, I compared the characteristics from that file to electronic PTO patent records.

[10] According to Mandel (2006), determining obviousness at the time the invention was made requires the fact-finder to "step backward in time to a moment when the invention was unknown." Adjudicators are biased towards finding obviousness in this determination because of the tendency to apply what has been learned subsequently, to what was known at the time. (Mandel 2006) Mandel (2006) admits, however, that despite the hindsight bias too many obvious patents may be upheld by courts because of factors including the presumption of validity.

[11] See footnote 4 and accompanying text.

innovation-based validity decisions). For example, without accounting for selection bias, I cannot infer that all amateur inventor patents are more likely to lack innovation value from a result that litigated inventor patents are more likely to be invalidated. Perhaps amateur inventors have lower stakes than other owners and thus lose more frequently by litigating weaker patents through final decision.

3.3. Probit Model with Selection Effects

In my multivariate analysis, I attempt to control for selection effects by utilizing an econometric model based on Heckman's two-step method (1979). Within Heckman selection models, there are two equations: 1) The outcome equation; and 2) The selection equation. Selection bias exists when the error term in the outcome equation is correlated with the error term in the selection equation. Thus, Heckman's (1979) insight was showing selection bias is essentially omitted variable bias.

The probit model with selection effects I use may be considered a system of equations for two unobserved responses, I_i^* and S_i^*. The observed responses, selection for an innovation-based invalidity decision ("S_i") and invalidity ("I_i") are generated according to $I_i = 1$ if $I_i^* > 0$ ($I_i = 0$ otherwise) and $S_i = 1$ if $S_i^* > 0$ ($S_i = 0$ otherwise), where:

(1) $\quad I_i^* = \textbf{\textit{x'}}_i \boldsymbol{\beta} + \lambda \varepsilon_i + u_i$

(2) $\quad S_i^* = \textbf{\textit{x'}}_i \boldsymbol{\gamma} + \varepsilon_i + v_i$

I obtain maximum likelihood estimates for this system of equations using Stata's "heckprob".

Whether selection effects exist can be determined from the random effects. u_i and v_i are random effects separate to each equation and ε_i is the shared random effect. If there are selection effects, λ and thus the correlation between the residuals of the two equations, ρ, is nonzero.

$\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$ are observed variables that explain I_i and S_i respectively. $\boldsymbol{\beta}$ includes the patent, party and adjudication characteristics I describe in the next section. As Marco (2004) explains, patent and patent owner characteristics that influence validity decisions also theoretically influence selection for such decisions. I include these traits in $\boldsymbol{\gamma}$. However, adjudication and alleged infringer traits are unobserved for patents not selected for adjudication and thus excluded from the selection equation.

To use this model, I need a set of patents not selected for an innovation-based invalidity determination.[12] Following Marco (2004) I create a matched sample that includes two patents for each of the 980 adjudicated patents. The population of possible matches for each adjudicated patent is all granted utility patents with the same initial application date. I generate a simple probability weight to account for the matched patents being only a small set of the entire population.[13] Now that I have described my model, I detail the patent, party and adjudication characteristics I analyze and report my results.

4. RESULTS

In Section 4.1, I report my sample's overall invalidity rate and explain the patent, party and adjudication traits that may influence these invalidity decisions. I report descriptive statistics and bivariate validity rate comparisons for each trait. I report my multivariate results in Section 4.2.

4.1. Descriptive Statistics and Bivariate Comparisons

Innovation-Based Invalidity Rates

For each final decision I located, I determined whether the patent was found invalid in whole or in part on the basis of anticipation and/or obviousness. Again, patent validity is determined on a claim-by-claim basis. Thus, I designate as "Part" invalid patents with some but not all claims asserted by the owner invalidated by the court. I define patents as "All" invalid if the adjudicator invalidated all asserted claims and "Not" invalid if no claim was invalidated. As seen in Table 1, partial invalidation is least common. Thus asserted claims usually stand or fall together.[14]

The validity rates for anticipation and obviousness decisions are very similar—73 versus 68 percent. Demonstrating the tie between these two invalidity defenses, nearly two thirds (647 of 980) of the patents in my sample faced decisions on both anticipation and obviousness.[15]

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[12] To avoid identification problems, the model also requires that the selection equation includes an exclusion restriction. (Marco 2004) Before presenting my results in Part 4.2, I explain my choice for this key variable.

[13] Because there are two matched patents for each adjudicated patent, I weigh each matched patent by one half the total number of granted patents applied for during the same day as each adjudicated patent.

[14] This is consistent with Allison and Lemley (1998), who found courts made separate claim-by-claim invalidity determinations for only 7 of 299 (2.34 percent) litigated patents in their sample.

[15] Anticipation alone was decided for 138 patents and obviousness alone for 195 patents.

Because of the similar interpretation I give them—a legal determination that the patent at issue lack innovation value—I combine anticipation and obviousness decisions for the remainder of my analysis and refer to them as innovation-based validity decisions ("A or O" in all tables).[16] I find that 37 percent of patents subject to an innovation-based validity decision were at least partially invalidated.

Table 1

VALIDITY RATES FOR INNOVATION-BASED DECISIONS

	All Invalid	Part Invalid	Not Invalid	Total
Anticipation:				
# of Patents	164	49	572	785
% of Total	(20.9)	(6.2)	(72.9)	
Obviousness:				
# of Patents	226	43	573	842
% of Total	(26.8)	(5.1)	(68.1)	
	All A or O	Part A or O	Not A or O	Total
Combined:				
# of Patents	296	69	615	980
% of Total	(30.2)	(7.0)	(62.8)	

Patent Characteristics

Industry and Technology. I assigned each patent to one or more of the industry and technology categories developed by Allison, Lemley, and Walker (2009) in response to limitations in the PTO classification system.[17] The first three columns of Table 2 report the number (and percentage) of adjudicated patents in my sample in each industry found "All", "Part" or "Not" anticipated or obvious. The fourth column reports the total number of patents in my sample I assigned to that industry.

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[16] I stress that outside the separate anticipation and obviousness statistics I report at the top of Table 1, my analysis includes only a single data point for each patent-case pair. Thus, the 23 patents I identify as found obvious but not anticipated in a single lawsuit and the two found anticipated but not obvious are included only once in my sample. I code all of these as being found "A or O" invalid since they were in fact invalidated on one of these two bases.

[17] These industry and technology categories are precisely defined starting on page 6 of Allison, Lemley, and Walker (2009). To ensure accuracy, I reviewed the invention description contained in the PTO's electronic copy of each patent and compared it to Allison, Lemley, and Walker's (2009) category definitions. I further compared the classifications I assigned to the Hall, Jaffe and Tratjenberg (2001) (HJT) PTO-based classification it was assigned in the NBER data file. I found that Allison, Lemley, and Walker (2009) and HJT's classifications are overwhelmingly consistent. HJT (2001) developed a technology classification system based on the 400+ 3-digit main PTO classes. HJT's system includes six technology classes (Chemical, Computer & Communication, Medical & Drug, Electrical, Mechanical and Other) and 37 subclasses. With 13 identified industry categories and 9 technology categories, Allison, Lemley, and Walker's (2009) methodology allowed me to analyze more types of patents than if I had used HJT's 6 classes, while ensuring there are sufficient data points for each type for econometric analysis.

Table 2

INNOVATION-BASED VALIDITY DECISIONS & RATES BY PATENT INDUSTRY

	All A or O	Part A or O	Not A or O	Total
*Computer	74 (37%)	25 (12%)	102 (51%)	201
Semiconductor	4 (11%)	5 (14%)	26 (74%)	35
Electronics	30 (27%)	11 (10%)	70 (63%)	111
*Medical	28 (22%)	8 (6%)	93 (72%)	129
Pharmaceuticals	30 (29%)	1 (1%)	72 (70%)	103
Biotechnology	10 (29%)	1 (3%)	23 (68%)	34
Chemical	14 (35%)	0 (0%)	26 (65%)	40
Communications	39 (29%)	16 (12%)	78 (59%)	133
Transportation	17 (26%)	9 (14%)	40 (61%)	66
*Energy & Utility Service	4 (13%)	1 (3%)	27 (84%)	32
Financial	5 (29%)	1 (6%)	11 (65%)	17
Consumer Goods & Service	69 (31%)	15 (7%)	136 (62%)	220
Construction	10 (27%)	3 (8%)	24 (65%)	37
Other	16 (29%)	1 (2%)	38 (69%)	55

In bivariate comparison[18], I find that Computer patents were more likely to be invalidated on innovation-based grounds while Semiconductor, Medical, Pharmaceutical, Biotechnology and Energy Services patents were less likely. These differences are consistent with conventional opinion of which industries contain more or less non-innovative patents. However, only the differences for the Computer, Medical, and Energy Service industry are significant.

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[18] In Table 2 and subsequent descriptive statistics tables, I identify significantly different validity rates for a given characteristic with an asterisk ("*"). For categorical variables, I tested the null that there is no difference in the validity rate between patents with and without that characteristic using both Chi-square and Fisher's exact tests. For other variables, I use independent samples t-tests. In each case, significance represents a p value < 0.05.

Table 3 reports the same information as Table 2 but for Allison, Lemley, and Walker's (2009) technology categories. Software Business Methods are a subset of Pure Software which in turn is a subset of Software patents. Allison, Lemley, and Walker (2009) define Software broadly as including patents with "at least one claim element" consisting of "data processing". Pure Software patents consist solely of data processing and Business Methods "cover methods for conducting business transactions."

All three software categories are significantly more likely to be invalidated, as are Electronics patents, many of which I also designated Part Software patents because they include data processing. Software Business Methods performed particularly poorly and alone were more likely to be at least partially invalidated than found valid. This is consistent with Jaffe and Lerner's (2004) criticism of new technology patents. However, Biotechnology patents do not have a significantly different win rate (p value = 0.15). Chemistry patents are also significantly less likely to be invalidated.

Table 3

INNOVATION-BASED VALIDITY DECISIONS & RATES BY PATENT TECHNOLOGY

	All A or O	Part A or O	Not A or O	Total
*Software	103 (38%)	31 (11%)	138 (51%)	272
*Pure Software	87 (38%)	24 (10%)	119 (52%)	230
*Software Business Method	34 (45%)	9 (12%)	32 (43%)	75
Mechanical	104 (29%)	25 (7%)	230 (64%)	359
*Electronics	98 (34%)	26 (9%)	164 (57%)	288
Optics	11 (31%)	0 (0%)	24 (69%)	35
Imaging	15 (45%)	1 (3%)	17 (52%)	33
Biotechnology	10 (24%)	1 (2%)	30 (73%)	41
*Chemistry	53 (27%)	2 (1%)	143 (72%)	198
Other	12 (32%)	1 (3%)	24 (65%)	37

Other Patent Characteristics

Prior research has used patent characteristics other than industry and technology to proxy patent value. From the NBER data file I obtained measures for two of these as well as each patent's grant year and the number of days between each patent's initial filing date and grant date. Summary statistics for these patent traits are reported in Appendix Table A1.

Application Duration. Patents applications pending before the PTO for a longer period may have been subject to higher scrutiny with respect to their novelty and non-obviousness such that we would expect them to better survive an invalidity challenge. Conversely, longer duration may signal the application's subject matter was less clear and thus more likely to be invalidated. (Marco 2004) To test these possibilities, I measure the number of days between each patent's initial application date and grant date. I find that patents judged not invalid were on average prosecuted 36 days less than those found at least partially invalid. However, this difference is insignificant (p value = 0.33).

Grant Year. Older patents may better survive innovation-based invalidity challenges as there was more time for alleged infringers to litigate their validity and because there is less prior art on which to invalidate them. Patents judged valid were on average granted a year before those at least partially invalidated. This difference is statistically significant (p value = 0.00).

Number of Claims. We may expect that patents with more claims are more valuable for two reasons. First, more claims suggests greater applicant investment since the PTO charges in part by the number of claims. (Allison, Lemley, and Moore 2004) Second, claims specify the ideas to be protected and more claims may mean more ideas. (Landjouw and Schankerman 2001) Surprisingly, however, I find patents judged valid have significantly fewer claims than those judged invalid (p value = 0.03).

Number of Citations. The second value proxy I analyze is the number of other patents that cite a patent as relevant prior art. (Allison, Lemley, and Walker 2009) I utilize the average number of citations per claim per year. Inventors may cite a patent because it important to their field. (Shrestha 2001) Thus, patents with more citations may have more innovation value. However, the difference in citations between valid patents and those at least partially invalidated is insignificant (p value = 0.36).

Party Characteristics

Now that I have introduced patent characteristics that may predict differences in win rates in innovation-based invalidity decisions, I turn to characteristics of the litigants themselves. I begin with the type of patent owner, the party characteristic most relevant to current arguments that certain types of patents are more likely to have negligible value as innovation.

Type of Patent Owner. Given the widespread criticism of the value of the patents enforced by so called patent "trolls" which variously include patent licensing firms alone or all non-practicing entities (NPEs), the types of patent owners asserting the adjudicated patents in my sample is potentially very important. NPEs as defined by Allison, Lemley, and Walker (2011) include licensing firms, individual inventors, and not-for profit research entities. I expect these to have different ownership motivations, enforcement behavior and types of patents. Accordingly, I categorize patent owners in my sample as product firms, individual inventors, licensing firms and others.

I categorized owners by first obtaining their names from the IPLC and then obtaining their description from internet searches. Product companies are those identified as offering any product or service for sale that embodies their patented ideas. I separated product firms into large and small, with large firms being publicly traded or included on Forbes' list of the Largest Private Companies.[19]

The owners I name individual inventors were named parties to the lawsuits in my sample or litigated in the name of a shell LLC that solely enforces that inventor's patents. In both cases, I verified the individual was the patent's inventor from PTO records or court pleadings.

Patent licensing firms were either self identified as such in court pleadings, firm websites or in media coverage of their litigation. I sought to narrowly include in this category only firms in the business of generating revenue from the patents they own. I designated close cases as either product companies or inventors. Finally, a few patent owners in my sample were government, university or other not-for-profit research organizations. I designated these owners as "Other".

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[19] Forbes' list for 2011 is available at http://www.forbes.com/lists/2011/21/private-companies-11_rank.html.

Table 4 reports that three owner types possess significantly different invalidity rates. Licensing firm and inventor patents were less likely to be judged valid (48.3 and 52.6 percent respectively). Thus, licensing firm patents join business methods as a rare species more likely to be at least partially invalidated. Finally, small product firm patents had a higher validity rate than other patents.

Table 4

OWNER TYPE SUBJECT TO INNOVATION-BASED INVALIDITY DECISIONS

	All A or O	Part A or O	Not A or O	Total
*Inventor	42	3	50	95
	(44.2%)	(3.2%)	(52.6%)	
*Licensing Firm	56	20	71	147
	(38.1%)	(13.6%)	(48.3%)	
Large Product	131	26	295	452
	(29.0%)	(5.7%)	(65.3%)	
*Small Product	60	15	183	258
	(23.3%)	(5.8%)	(70.9%)	
Other	7	5	16	28
	(25.0%)	(17.9%)	(57.1%)	

Other Party/Suit Characteristics

Now that I have discussed the owner type, I turn to other characteristics of the parties that may impact the likelihood a patent is invalidated on innovation-based grounds. Invalidity rates for the first three characteristics, which are indicators, are listed in Appendix Table A2. Summary statistics for each of the second three numerical variables are listed in Appendix Table A3.

Foreign Party. Whether a patent owner or an alleged infringer is a foreign or U.S. entity may predict success in innovation-based invalidity decisions as it may be more expensive for foreign entities to litigate in the United States. I thus determined whether patent owners and alleged infringers were foreign or domestic entities. I find foreign owned patents were not significantly more or less likely to be invalidated (p value = 0.43). In contrast, foreign alleged infringers were significantly less successful in proving invalidity (28.5 versus 38.9% with a p value = 0.02).

Large Alleged Infringer. The financial resources of alleged infringers should predict their success in proving invalidity. All alleged infringers in my sample are product firms, which makes sense given infringement requires making, using or selling embodiments of the patented technology. As with

product firm owners, I determined whether alleged infringers in my sample are large or small.[20] With more resources, I expect large firms may mount more effective invalidity challenges. Consistent with my expectations, patents asserted against large alleged infringers are significantly more likely to be at least partially invalidated (40.6% versus 29.9% with a *p* value = 0.00).

Referencing Table A2, it is also interesting that nearly 70 percent of patents in my sample were asserted against large firms. This may represent a combination of large firms being more likely to defend through adjudication and patent owners targeting large firms with deeper pockets.

Number of Patents Asserted.   I collected the number of patents asserted in each case by the "primary" patent owner. By "primary" I mean the instigator of infringement allegations and do not include patents asserted in infringement counter-claims against that "primary" owner.   Owners asserting more patents at once may possess strong patent portfolios less likely to be invalidated. (Allison, Lemley, and Moore 2004) However, I find patents invalidated on innovation-based grounds are asserted in cases where their owners are asserting significantly more total patents (*p* value = 0.03).

Number of Cases Patent Asserted. I next determine the total number of filed lawsuits in which each of the patents in my sample was asserted. The relationship between this and the likelihood a patent is invalid is interesting in light of Allison, Lemley, and Walker's (2011) rejection of the idea patent owners who file multiple lawsuits "might do so because they have a stronger than average patent and therefore face less risk of invalidity." Allison, Lemley, and Walker (2011) report that owners of the "most-litigated" patents lost adjudicated lawsuits much more frequently than once-litigated patent owners. Allison, Lemley, and Walker (2011) results suggest the possibility that repeat patent plaintiffs are irrational in not suing all alleged infringers in one action so as to avoid re-litigating validity issues.

Measured as a simple count of total lawsuits filed, I find that the patents that survived innovation-based invalidity challenges were asserted in significantly more cases than those found invalid (*p* value = 0.02). This is at odds with Allison, Lemley, and Walker's (2011) results and suggests owners do not

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[20] Where there are multiple alleged infringers in a lawsuit, I designate the alleged infringer as large if one or more of the alleged infringers is large.

irrationally litigate patents with dubious validity in multiple suits. I leave detailed investigation of this

discrepancy to my next article. For now, I note that when I compare the validity rates of the most

litigated patents in my sample, as defined by Allison, Lemley, and Walker (2011), to those litigated once,

I find the most-litigated are less likely to be invalidated (24.0% versus 41.5%, *p* value = 0.02). Allison,

Lemley, and Walker's (2011) findings do not appear to apply to innovation-based invalidity.

Number of Alleged Infringers. Finally, I consider the number of alleged infringers in the

lawsuit. There may be a positive relationship between this number and the invalidation rate if the

infringers join their resources in a common defense. (Allison, Lemley, and Walker 2011) However, there

may be a negative relationship if owners assert stronger patents against many alleged infringers. I find

support for the second theory in that patents judged valid were asserted against more alleged infringers.

However, this difference is not significant (*p* value = 0.34).

Adjudication Characteristics

I now discuss adjudication characteristics that may influence innovation-based invalidity

decisions. The number of patents found invalid, by trait, is listed in Appendix Table A4.

Date of Adjudication. Courts may have become more likely to invalidate patents on the basis of

obviousness after the U.S. Supreme Court's decision in *KSR Int'l Co. v. Teleflex, Inc.* (550 U.S. 398

[2007]). In *KSR*, the Court empowered lower courts to consider more types of evidence of obviousness

than previously available in rigidly applying the TSM test.[21]

Analyzing annual invalidity rates, I found evidence courts may be utilizing this extra discretion.

The innovation-based validity rate in cases in my sample decided before 2007 was 67 percent. This

dropped to 52 percent in 2007. Thereafter, the rate increased to 63 percent. To test whether *KSR* had a

significant effect, I generated a variable indicating whether the invalidity decision was made after *KSR*

was decided on April 30, 2007. I find the validity rate did in fact decrease from 66.1 to 60.7 percent.

However, this result barely misses statistical significance (*p* value = 0.08).

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[21] See Simic (2009) for a detailed description of the *KSR* decision.

Declaratory Judgment. I determined whether patents were litigated in infringement actions brought by the owner or in declaratory actions. Common sense suggests alleged infringers are more likely to initiate a declaratory action against patents with dubious validity. But Moore (2000) provides an alternative explanation—that juries are pro-plaintiff.[22] Regardless of the reason, I find patents are more likely to be at least partially invalidated in declaratory actions (47% versus 36% with p value = 0.03).

Level of Adjudication. I next determine whether final judgment was on summary judgment, trial (or JNOV) or appeal. The validity rate is not significantly different for summary judgment (p value = 0.32). However, trial decisions are more likely (73.3% with p value = 0.00) and decisions on appeal less likely (54.3% with p value = 0.00) to find validity.[23] The lower rate for CAFC decisions is in contrast to prior work suggesting CAFC is biased in favor of patent owners. (Thomas 2001; Barton 2003)

District Court. Forum shopping research finds factors including speed of adjudication, trial rate and patent owner win rate vary significantly by district court. (Lemley 2010; Moore 2005) I extend this work by determining whether innovation-based validity also varies by district court. My sample includes cases from 68 district courts, with most missing districts covering rural areas. Appendix Table A5 includes the 21 districts with 15 or more innovation-based validity decisions in my sample. The first 12 districts listed include the 10 districts with the most filed patent lawsuits according to the IPLC.[24] These facts suggest my sample is geographically representative.

One may expect owners to gravitate towards patent-friendly districts, particularly because they have discretion in selecting the district in which to file suit. The significantly higher 76 percent validity rate for the Eastern District of Texas ("TXED"), known as particularly owner-friendly, supports this idea. However, several of the most patent-litigation intensive districts in my sample have significantly lower

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[22] Moore (2000) finds patent owners win 65% of infringement suits but only 42% of declaratory actions decided by juries. She found the patent owner win rate nearly identical and close to 50% when the judge adjudicated. However, juries decide innovation-based validity much more frequently than judges.

[23] The lower trial invalidity rate is driven by the prevalence of juries. Of the 648 invalidity decisions either finally adjudicated at trial or adjudicated there before a later appellate decision, 70% were decided by juries. And in my sample, juries validated patents significantly more often than judges (76.9% versus 63.9% with p value = 0.01).

[24] While the Middle District of Florida ("FLMD") and the Western District of Wisconsin ("WIWD") are not in the IPLC top 10, they are also active districts for patent litigation.

validity rates. These include the Northern District of California ("CAND"), the Northern District of Illinois ("ILND"), the Eastern District of Michigan ("MIED") and the District of Nevada ("NV").

Before offering owners of patents with questionable innovation value advice on where to file suit, however, I must determine if these differences persist after accounting for differences in other relevant patent, party and adjudication characteristics. I thus now report my multivariate results.

4.2. Multivariate Analysis

But before reporting the significant predictors of innovation-based invalidity from the selection corrected probit model described in section 3.3, I address a lingering econometric issue with this model. Because the explanatory variables I use for my selection equation are a subset of those in the invalidity equation, there may be an identification problem. (Marco 2004) I can resolve this issue with at least one variable in the selection equation that does not influence the win rate. However, it is difficult to theoretically eliminate any of my patent characteristics from the invalidity equation.

The best candidate for an exclusion restriction among the characteristics I analyze is whether or not a patent is foreign owned. I theorize that foreign patent owners are less likely to litigate their patents through adjudication because it is relatively more expensive. In contrast, foreign owners should not be more or less likely to win innovation based validity decisions after they have chosen to incur those costs.[25] I confirmed these ideas through unreported regressions of the likelihood a patent is invalidated on the foreign patent owner indicator. In none of these was foreign ownership even close to a significant predictor of invalidity. However, it is a negative and highly significant predictor of selection for an invalidity decision. Accordingly, I utilize foreign patent ownership as my exclusion restriction.

The first two columns of Table 5 report my results for both an uncorrected and selection corrected probit. The third column reports estimates for the selection equation used in the selection corrected regression. Concerning the invalidity equation, I include all patent, party and adjudication characteristics in both the uncorrected and corrected specification. This includes indicator variables for the most active

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[25] My adjudication controls account for the possibility that some adjudicators may be biased against foreign owners. Foreign ownership is not a significant predictor of innovation-based invalidity even if these controls are excluded.

district courts and I report their coefficients and significance in Table 6. I omit small product firm owner and trial adjudication categories. In the selection equation, I include all patent and owner characteristics.

To simplify discussion of my results, I consolidate several of the industry and technology categories described in my bivariate analysis. I merge the Software and Pure Software categories into one Software indicator including all patents primarily claiming data processing.[26] Because they have been particularly criticized, I include a Business Method indicator for the subset of Software patents within that category. I use a "pure" Electronics technology category that omits all patents with at least one software claim. Finally, I omit Biotechnology as an industry category since all such patents in my sample fall within both the Biotechnology industry and technology category.

Selection Bias and the Selection Equation

Surprisingly, the estimates in Tables 5 and 6 and their significance is similar for both the uncorrected and corrected model. The reported correlation between the error terms of the two equations, ρ, is not significantly different than zero. Further, I cannot reject the null that the coefficients of the uncorrected and corrected models are the same, using either the likelihood-ratio (chi-squared = 1.45 ($p > 0.23$)) or related Wald test (chi-squared = 0.05 ($p > 0.82$)). Thus the outcome equation does not appear to suffer from significant selection bias.

Nevertheless, the selection equation shows that there are interesting selection effects. Computer, Electronics, Medical, Pharmaceutical, Communications, Energy, Consumer, Construction, and Other industry patents are more likely to face an innovation-based validity decision. Concerning technology, Software, Method, Mechanical, Biotechnology and Chemistry patents are more, and Imaging patents less, likely to be selected. Concerning ownership, licensing firm patents are more likely and inventor and other-owned patents less likely to face an invalidity decision. Finally, patents with more claims and citations are more likely to be selected.

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[26] Upon inspection, the Software patents in my sample that do not fall within Allison, Lemley, and Walker's (2009) Pure Software category are substantially data processing with non-software components describing the electronic means to implement the software's task. For example, patent number 6,035,027 claims data processing methods of minimizing long distance telephone fees but describes the architecture that can implement those methods.

Table 5

PROBIT ESTIMATION OF LIKELIHOOD A PATENT IS INVALIDATED FOR ANTICIPATION OR OBVIOUSNESS

	Uncorrected Probit	Selection Corrected	Selection Equation
Industry:			
Computer	-.153 (.195)	-.134 (.240)	.343** (.090)
Semiconductor	-.652* (.307)	-.643* (.307)	-.025 (.162)
Electronics	-.129 (.191)	-.104 (.210)	.217* (.100)
Medical	-.489* (.196)	-.450+ (.270)	.333** (.084)
Pharmaceutical	.071 (.260)	.123 (.386)	.767** (.103)
Chemical	.184 (.268)	.180 (.266)	.068 (.087)
Communications	-.162 (.174)	-.131 (.256)	.444** (.090)
Transportation	-.140 (.230)	-.125 (.233)	.105 (.080)
Energy/Utility Service	-.625* (.342)	-.644+ (.349)	.165+ (.095)
Financial	-.698* (.404)	-.621 (.454)	.429 (.322)
Consumer Good/Service	-.062 (.169)	-.017 (.294)	.614** (.077)
Construction	-.147 (.259)	-.113 (.295)	.385** (.114)
Other	-.287 (.263)	-.271 (.297)	.360** (.093)
Technology:			
Software	.551* (.255)	.580* (.259)	.184+ (.100)
Business Method	.479* (.212)	.515* (.255)	.530** (.144)
Mechanical	.296 (.181)	.317 (.218)	.333** (.074)
Electronics	.261 (.179)	.260 (.179)	.075 (.074)
Optics	.135 (.283)	.130 (.285)	-.010 (.121)
Imaging	.158 (.316)	.151 (.338)	-.291** (.100)
Biotechnology	-.289 (.336)	-.206 (.374)	.432** (.118)
Chemistry	-.197 (.197)	-.170 (.217)	.219** (.071)
Other	.208 (.291)	.225 (.289)	.042 (.113)
Other Patent:			
Application Duration	-.00013 (.00010)	-.00013 (.00010)	-.00002 (.00005)
Grant Year	.0403** (.0112)	.0422** (.0139)	-.0186* (.0041)
Log # Claims	-.092 (.061)	-.069 (.145)	.308** (.031)
Ave Citations / Clm / Yr	-.776 (.549)	-.687 (.732)	1.13** (.21)
Ave Citations Squared	.311 (.346)	.290 (.356)	-.155 (.101)
Patent Owner:			
Inventor	.214 (.178)	.212 (.200)	-.212** (.062)
Licensing Firm	.672** (.188)	.735* (.366)	1.057** (.142)
Large Product Firm	.206 (.138)	.213 (.140)	.044 (.047)
Other	.567+ (.328)	.546 (.365)	-.382** (.095)
Party:			
Foreign Owner			-.387** (.042)
Foreign Defendant	-.298* (.139)	-.302* (.138)	
Large Defendant	.188 (.125)	.191 (.124)	
# Patents Asserted	.0033 (.0084)	.003 (.008)	
# Suits Patent Asserted	-.0423* (.0195)	-.0411* (.0193)	
# Defendants in Suit	-.0326* (.0161)	-.0339* (.0160)	
Adjudication:			
Decided after KSR	-.011 (.105)	-.020 (.105)	
Declaratory Judgment	.505** (.162)	.500** (.163)	
Appeal	.507** (.104)	.496** (.105)	
Summary Judgment	-.082 (.147)	-.086 (.147)	

NOTE.—Sample includes 980 patents litigated in 579 cases filed between 2000 and 2010. Robust standard errors included in parenthesis.

+ $p < .10.$ * $p < .05.$ ** $p < .01.$

Table 6

DISTRICT COURT PREDICTORS FOR TABLE 5 ESTIMATION

	Uncorrected Probit	Selection Corrected
District Court:		
TXED	-.524** (.181)	-.522** (.181)
CAND	.196 (.195)	.197 (.194)
DE	-.351$^+$ (.214)	-.352$^+$ (.214)
CACD	.010 (.205)	.009 (.205)
ILND	.399$^+$ (.236)	.399$^+$ (.236)
MA	-.478* (.229)	-.474* (.230)
NJ	.410 (.271)	.406 (.271)
CASD	-.486$^+$ (.289)	-.484$^+$ (.288)
MN	-.191 (.273)	-.188 (.273)
FLMD	.005 (.292)	.005 (.292)
WIWD	-.288 (.322)	-.289 (.321)
NYSD	.042 (.326)	.031 (.333)
AZ	-.986* (.479)	-.982* (.479)
TXSD	.236 (.375)	.239 (.374)
MIED	1.03** (.39)	1.03** (.39)
OR	-.304 (.364)	-.299 (.364)
MOED	.319 (.393)	.318 (.392)
NV	.510 (.360)	.508 (.359)
FLSD	-.335 (.359)	-.334 (.359)
OHND	-.083 (.368)	-.083 (.368)
TXWD	-.347 (.321)	-.344 (.321)

NOTE.— Robust standard errors included in parenthesis.
$^+$ $p < .10$.
* $p < .05$.
** $p < .01$.

Significant Predictors of Innovation-Based Invalidity

Turning to the invalidity equation, both Software and Business Method patents are significantly more likely to be invalidated. In the basic probit, Semiconductor, Medical, Energy and Financial patents are significantly less likely to be invalidated. However, in the selection-corrected model the Financial category is insignificance. The Energy and Medical categories are only significant to a 90 percent level.

Neither of the two patent characteristics frequently used to proxy value—number of claims and average citations—is a significant predictor of innovation-based validity. However, as noted, both are positive predictors that they will be selected for such decisions. Allison, Lemley, and Moore (2004) argue litigated patents tend to be more valuable to their owners than non-litigated patents because litigation is costly. If this theory is true, my results support the distinction that number of claims and average citations proxy private value but not a lower chance of lacking innovation value.

As for the remaining two prosecution-related patent characteristics, the first, grant year, is significant across all specifications. Thus, older patents are less likely to be invalidated. However, the second, application duration, is uniformly insignificant.

Licensing Firm is the only significant ownership predictor that a patent is invalidated. The indicator for Other owners is significant to the 90% confidence level in the uncorrected but not the corrected specification. For other party characteristics, patents asserted against foreign alleged infringers are significantly less likely to be invalidated. The number of alleged infringers and the total number of lawsuits in which a patent has been asserted are significant negative predictors that a patent is invalidated.

Finally, patents adjudged by CAFC are significantly more likely to be invalidated, as are those defended in declaratory actions. TXED, AZ, DE, MA and CASD are less likely, while MIED and ILND are more likely, to find validity. These results suggest forum-shopping opportunities exist.

Unconditional Probabilities

Just how many old or obvious patents exist? From my selection corrected model, I obtain estimates of the likelihood any patent within my population would be found invalid, regardless of whether it has been adjudicated.[27] I find the unconditional probability a patent is at least partially invalidated as anticipated or obvious is 0.28.[28] In other words, more than one in four patents granted by the PTO has at least one non-innovative claim. This result strongly supports Jaffe and Lerner's (2004) argument that the PTO has granted many patents on non-innovative ideas.

I estimate fewer non-innovative patents in most of the industries that are significant negative predictors of innovation-based invalidity. The unconditional probability that patents are at least partially invalidated is 0.13 for the energy industry, 0.16 for the semiconductor industry, and 0.20 for the medical industry. Financial patents have an unconditional probability of 0.38, higher than the rate for all patents. Why then is the financial industry category such a large, significantly negative predictor of innovation

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[27] In section 3.3, I defined my population as all patents applied for during the same days as the adjudicated patents.

[28] I determine this probability with all independent variables measured at their means. For the reported industry and technology probabilities, industry and technology variables are measured based on the percentage of patents in a given category that fall within each of the industry and technology categories. All other patent and adjudication characteristics are measured at their means.

based invalidity? The answer is that all financial industry patents in my sample protect either Software or Business Method technology. Thus, while financial patents have a higher than average invalidity rate, they are less likely invalid than other software patents.

Excluding business methods, Software patents have an unconditional probability of being at least partially invalid of 0.39. The probability is far higher for Business Methods (0.56). Finally, I estimate the unconditional probability that a licensing-firm-owned patent will be found at least partially invalid as 0.61, higher than that of the software and method patents they typically enforce.

5. DISCUSSION

My results have implications for many patent law and economics issues including the use of patent characteristics as value proxies and forum shopping. In this discussion, however, I focus on investigating the significantly different innovation-based invalidity rates across industries and technologies and for licensing firms.

5.1. Industry and Technology Differences

In both my basic probit and selection-corrected probit model I include many patent, party and adjudication characteristics that control for adjudication bias and selection effects including uncertainty, case quality, litigation costs, stake asymmetries and case value.[29] Across both models, and despite these controls, patents from several of the industries and technologies I analyze are uniformly significantly more or less likely to be adjudicated invalid as lacking innovation. These results strongly suggest that, whether or not litigated, patents in some industries or covering some technologies are in fact more or less likely to lack of innovation value. But what explains these differences?

Recall Jaffe and Lerner's (2004) argument that the PTO's examination process has been well functioning for established industries that rely on patents, but has failed to reject applications for patents on old ideas in "new" technologies. This distinction between old and established versus newly patented technology fits my results quite well. I find software and business methods are significantly more likely

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[29] See Marco (2004, pp. 7-12) for a detailed description of Waldfogel's (1995) version of the Priest-Klein model (1984) as applied to patent disputes and how different selection effects influence the observed win rate in relation to the population win rate.

to be invalidated on innovation-based grounds. Furthermore, patenting has long been important to the energy and medical device industries[30] and these patents have lower invalidity rates. (Arora 1997; Bessen and Meurer 2005a)

However, Jaffe and Lerner's (2004) third newly patented category, biotechnology, is not a significant predictor of innovation-based invalidity. Further, semiconductor firms did not rely on patents until after semiconductor patent rights were strengthened in the 1980s. (Hall and Ziedonis 2000) Thus, semiconductor patents which are less likely to be invalidated may also be considered a category of newly patented technology. There is, however, a clear distinction between medical, energy, semiconductor and biotechnology patents on the one hand and software and business method patents on the other—the first group consists of more definite and concrete claims while the second group covers more abstract ideas.

In contrast with Jaffe and Lerner (2004), Bessen and Meurer (2008) argue the main failure of the U.S. patent system has been the breakdown in notice of what particular patents protect. A key source of this breakdown was the increased patenting of software and business methods, which claim abstract ideas. With abstract ideas it is more difficult to "relate the words that describe patent boundaries to actual technologies." (Bessen and Meuer 2008) They argue the proliferation of patents with more uncertain scope exacerbated the increase in costly patent litigation. (Bessen and Meurer 2008)

Bessen and Meuer (2008) recognize that an increase in the number of patents with "fuzzy boundaries" is not inconsistent with the conclusion that there are more non-innovative patents. This is because PTO examiners are not immune from the greater uncertainty surrounding software and business methods, and may have been more likely to grant old or obvious patents covering these technologies. Thus, the underlying determinant of the likelihood a patent is invalidated on innovation-based grounds that I observe is not specifically whether the type of technology has been patented for only a short time but generally whether it is more difficult for the PTO to review.

In contrast to the abstract claims of software and method patents, claimed biotechnology and semiconductor innovation is concrete embodying, for example, a newly discovered use of one particular

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[30] Medical devices comprise 75 percent of the Medical patents in my sample.

genetic trait or a new semiconductor mask. While all four types of patents are relatively new, software and business method patents claim much more abstract content. This distinction both explain both why biotechnology and semiconductor patents are less likely to lack innovation value and why opportunistic licensing firms may be more likely to assert software and business method patents

5.2. Non-Practicing Entities Are Different

I found that regardless of technology, licensing firm owned patents are more likely to be invalidated on innovation-based grounds. Many theorize these entities engage in opportunistic litigation against large independently inventing product firms to induce licensing. (Bessen and Meuer 2005a) Opportunistic litigation is most successful where the scope of patent claims is uncertain. (Bessen and Meuer 2005a) Thus we may expect entrepreneurial owners of weak patents to focus on new technology patents with "fuzzy boundaries." (Bessen and Meuer 2008) That licensing firms asserted software or method patents in 75.5 percent (111 of 147) of their decisions in my sample supports this conjecture.

Further, referencing my selection effects discussion I observe that regardless of technology licensing firm patents are significantly more likely to be selected for an invalidity decision. If this reflects uncertainty, then it suggests some licensing firms may strategically assert patents whose content is even more uncertain than the average software and business method patent. Of course, the higher selection rate may also indicate higher valued disputes. But this is also consistent with the theory that licensing firms target the large producers of an industry with patents of potentially broad scope.

Whether they indicate more uncertainty, higher dispute values or both, the higher selection rate is consistent with the theory that licensing firms strategically litigate patents of broad and uncertain scope against product firms in litigation with potentially high damage awards. It just so happens that this business model utilizes the types of patents most likely to lack innovation value.

5.3. Uncertain Welfare and Policy Implications

While there are many non-innovative software and business method patents, many protect valuable innovation. This is evidenced by the fact courts frequently find these types of patents novel and non-obvious and grant their owners, including licensing firms, large damage awards. Conversely, alleged

infringers in the energy industry, the category least likely to lack innovation value, would still likely complain that a 13-percent unconditional invalidity rate is too high. My results thus suggest the PTO could tighten its prior art review regardless of the patent application's industry, technology or ownership.

Whether it would be welfare improving for the PTO to do so, however, is an open question. Less than two percent of granted patents are litigated. (Lemley & Shapiro 2005) Further, two-thirds of patents expire before their full term because their owners chose not to pay PTO maintenance fees. (Lemley 2001). If owners of the vast majority of patents are unwilling to invest in their defense or maintenance after they are granted, then it is likely wasteful to increase the scrutiny that all patents receive during prosecution.

Thus, if any legal reform targeting non-innovative patents is welfare improving, it will likely focus on patents considered particularly valuable by owners and prospective infringers. Perhaps the best option is to increase the ability of potential infringers to challenge the validity of claimed ideas during the application process or at least prior to litigation. The recently signed America Invents Act includes such reforms[31] but it will be some time before we possess sufficient data to determine their effect.

6. CONCLUSION

Exploring the characteristics of anticipation and obviousness adjudications is important because of the extreme ex post economic implication for the particular patents invalidated in these decisions. After years of PTO examination and litigation to a final decision on the merits, the trier-of-fact determined, by clear and convincing evidence, that these patents where never entitled to legal protection because they protect old or obvious ideas. Thus, they imposed significant costs on the PTO, alleged infringers and the courts without disclosing any appreciable innovation.

I estimate a surprising 28 percent of all patents would be at least partially invalidated as anticipated or obvious if litigated. I cannot say whether this number is inefficiently high, but this estimate strongly supports Jaffe and Lerner's (2004) assertion that non-innovative patents are common. Further, consistent with their and other recent criticism, software and business method are even more likely to lack

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[31] The Act retains existing ex parte reexamination (35 U.S.C. § 302), adds preissuance submissions by third parties (amending 35 U.S.C. § 122), expands interpartes reexamination (modifying 35 U.S.C. §§ 311-320) and adds post-grant review (adding 35 U.S.C. §§ 321-330).

innovation value. Patents protecting innovation in the semiconductor, medical and energy industries are less likely to lack innovation value. These differences plausibly depend on the relative difficulty PTO examiners face in comparing claimed ideas to the relevant prior art. In turn, this difficulty likely depends on the size of the existing body of relevant prior art and relative uncertainty of the content of the claims.

I find evidence that licensing firms are strategic, aggressively asserting software and business method patents with more uncertain meaning and scope. This business model is costly, however, as the patents they select are even more likely to lack innovation value than the average software or method patent. In my next paper I will further investigate the behavior of licensing firms and other repeat patent plaintiffs in light of my finding here of a negative relationship between the number of lawsuits in which a patent is asserted and its likelihood of lacking innovation. This contrasts with Allison, Lemley, and Walker's (2011) conclusion that owners of the "most-litigated" patents act irrationally.

Finally my analysis has revealed other interesting characteristics of innovation-based invalidity decisions. These inform past patent litigation research on the connection between patent characteristics and value and the bias of different adjudicators.

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APPENDIX

Table A1

SUMMARY AND INVALIDITY STATISTICS FOR OTHER PATENT CHARACTERISTICS

	All A or O	Part A or O	Not A or O	Total
Application Duration:				
Mean	853.2	823.0	882.4	869.1
Median	714	791	740	736
Standard deviation	483.9	304.0	609.6	556.7
Year PTO Granted Patent:				
Mean	1999.4	1998.2	1997.8	1998.2
Median	2000	1999	1998	1999
Standard deviation	4.63	4.99	5.12	5.01
# of Patent Claims:				
Mean	29.8	27.5	25.6	27.0
Median	21	21	20	20
Standard deviation	34.5	21.4	22.6	26.8
# of Citations / Claim / Year:				
Mean	0.102	0.113	0.119	0.113
Median	0.035	0.044	0.048	0.044
Standard deviation	0.393	0.192	0.206	0.277

Table A2

INNOVATION-BASED VALIDITY DECISIONS & RATES BY PARTY INDICATOR CHARACTERISTICS

	All A or O	Part A or O	Not A or O	Total
Party Domicile:				
Foreign Patent Owner	37	6	83	126
	(29.4%)	(4.7%)	(65.9%)	
Domestic Patent Owner	259	63	532	854
	(30.3%)	(7.4%)	(62.3%)	
*Foreign Alleged Infringer	36	7	108	151
	(23.8%)	(4.6%)	(71.5%)	
*Domestic Alleged Infringer	260	62	507	829
	(31.4%)	(7.5%)	(61.1%)	
Size of Alleged Infringer:				
*Large Firm	227	47	402	676
	(33.6%)	(7.0%)	(59.5%)	
*Small Firm	69	22	213	304
	(22.7%)	(7.2%)	(70.1%)	

Table A3

SUMMARY AND INVALIDITY STATISTICS FOR NUMERICAL PARTY/SUIT CHARACTERISTICS

	A or O	Part A or O	Not A or O	Total
# of Patents Asserted:				
Mean	5.08	4.58	4.21	4.50
Median	3	3	3	3
Standard deviation	5.64	8.58	5.00	5.53
# of Cases Patent Asserted:				
Mean	2.61	2.39	3.30	3.02
Median	2	2	2	2
Standard deviation	2.85	2.32	5.31	4.55
# of Alleged Infringers:				
Mean	2.39	2.64	2.64	2.56
Median	1	1	1	1
Standard deviation	2.73	3.27	3.57	3.32

Table A4

INNOVATION-BASED VALIDITY DECISIONS & RATES BY ADJUDICATION CHARACTERISTIC

	All A or O	Part A or O	Not A or O	Total
Date of Adjudication				
Before KSR	98	28	246	372
	(26.3%)	(7.5%)	(66.1%)	
After KSR	198	41	369	608
	(32.6%)	(6.7%)	(60.7%)	
Declaratory versus Infringement:				
*Infringement Action	261	58	564	883
	(29.6%)	(6.6%)	(63.9%)	
*Declaratory Action	35	11	51	97
	(36.1%)	(11.3%)	(52.6%)	
Level of Adjudication				
*Appeal	191	34	267	492
	(38.8%)	(6.9%)	(54.3%)	
*Trial or JNOV	77	15	253	345
	(22.3%)	(4.3%)	(73.3%)	
Summary Judgment	28	20	95	143
	(19.6%)	(14.0%)	(66.4)	
Judge versus Jury				
*Bench or JNOV	67	3	123	193
	(34.7%)	(1.6%)	(63.7%)	
*Jury	84	21	350	455
	(18.5%)	(4.6%)	(76.9%)	

Table A5

INNOVATION-BASED INVALIDITY DECISION BY DISTRICT COURT HEARING SUIT

District Court	All A or O		Part A or O		Not A or O		Total
*TXED	26	(20)	5	(4)	99	(76)	130
*CAND	31	(34)	13	(14)	46	(51)	90
*DE	15	(19)	3	(4)	62	(78)	80
CACD	24	(38)	3	(5)	36	(57)	63
*ILND	30	(55)	4	(7)	21	(38)	55
MA	10	(23)	3	(7)	31	(70)	44
NJ	15	(39)	1	(3)	22	(58)	38
CASD	8	(23)	2	(6)	25	(71)	35
MN	10	(35)	0	(0)	19	(66)	29
FLMD	10	(37)	0	(0)	17	(63)	27
WIWD	2	(8)	6	(25)	16	(67)	24
NYSD	8	(42)	0	(0)	11	(58)	19
AZ	2	(11)	1	(6)	15	(83)	18
TXSD	6	(33)	1	(6)	11	(61)	18
*MIED	9	(53)	4	(24)	4	(24)	17
OR	3	(18)	4	(24)	10	(59)	17
MOED	4	(25)	1	(6)	11	(69)	16
*NV	7	(44)	3	(19)	6	(38)	16
FLSD	5	(33)	0	(0)	10	(67)	15
OHND	4	(27)	1	(7)	10	(67)	15
TXWD	8	(53)	0	(0)	7	(47)	15
Other 47	59	(29.6)	14	(7.0)	126	(63.3)	199
Total	296	(30.2)	69	(7.0)	615	(62.8)	854

NOTE.—Percentage of patents adjudicated by each court that fall within each decision category in parenthesis.