THE ECONOMICS OF PATENT LITIGATION: AN EMPIRICAL ANALYSIS IN THE U.S. FROM 1996 TO 2010

by

Javad Eskandarikhoee

A dissertation submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Economics

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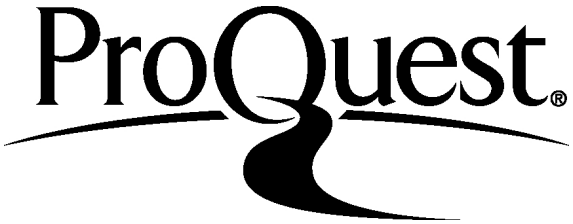

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I dedicate this dissertation to my wonderful family, Sedigheh, Amir, Hori and my lovely wife, Farnaz. Thank you for always being there for me. Without your love and support I would not be here today.

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ABSTRACT

I investigate the economics of patent litigation and various court outcomes involving patent lawsuits from 1996 to 2010 in the U.S. by linking patent litigation data from the Federal Judicial Center (FJC) to patent data from the United States Patent and Trademark Office (USPTO) and litigants' financial characteristics from the COMPUSTAT database.

I present a framework for testing two types of models to explain the behavior of plaintiffs and defendants during the patent litigation process. I begin with a decision model to examine the determinants of patent litigation and various court outcomes. I provide strong evidence that demonstrates that the rapid increase in patent litigation can be explained by increases in firm values for the number of patents per dollar of R&D spending, capital expenditures, total R&D spending, market value, scale, liquidity level, and patent portfolio quality (measured by originality, generality, and citations). I conclude that both litigants' characteristics and patent characteristics are important factors driving this increase.

Secondly, I present a selection model to investigate how the selection process affects litigants' characteristics in suits filed in relation to the distribution of patentees. I provide evidence that suits filed by pools of potential plaintiffs with greater dispersions in the distribution of their litigation costs will have lower plaintiff win rates and lower rates of granted preliminary injunctions. I conclude that patentees with higher-quality patent portfolios are more likely to win a lawsuit and more likely to

receive a preliminary injunction than other patentees. I find that the results are consistent with the implications of the selection model.

Chapter 1

INTRODUCTION

Patent litigation has increased significantly in the last two decades in the United States. The number of patent suits filed in U.S. federal courts has more than doubled since the mid-1990s. There has been a similar increase in the number of patent settlements and other court outcomes resulting from lawsuits for the same period. Figure 1.1 shows the trends in granted patents, patent suits filed, and settled patents, and settled & probably settled patents. Figure 1.2 demonstrates the positive trend of patent suits filed per granted patents by the United States Patents and Trademark Office (USPTO) from 1996 to 2010. Understanding patent litigation and various court outcomes has attracted the attention of a number of distinguished academics (e.g., Bessen and Meurer, 2005; Lerner, 1995, 2010; Lanjouw and Schankerman, 2001a, 2001b, 2004; Schankerman and Scotchmer, 2001; Galasso and Schankerman, 2010; and Somaya 2003).

In economic theory, patents are means to encourage innovation by providing a limited monopoly to the inventor in return for collection of license fee and/or royalty. However, Bessen and Meurer (2008) believe that "the patent system provides little innovation incentive to most public firms." They assert four reasons of patent system failure: fuzzy or ambiguous boundaries of patents, hiding patent applications from public access to boundary information, unclear possession and the scope of rights, and patent flood harms (patent flood harms refer to the harms because of high search costs,

delays, and low quality of examination due to workloads). Therefore, the legal system is seen as an important means to remedy patent system failure. Patent lawsuits can play a critical role by enforcing patent rights and supporting patent holders to continue to invest in R&D and other innovative efforts.

Some researchers, however, assert that patent litigation and the threats it poses have an adverse effect on innovation. Lerner (1995) asserts that small firms avoid investing in R&D when the threat of litigation from larger firms remains high. Similarly, Lanjouw and Lerner (2001) show that the use of preliminary injunctions by larger firms can adversely affect R&D investment by small firms. Lanjouw and Schankerman (2004) argue that information on court outcomes can help firms assess ex-ante litigation risk. They argue that the threat of costly enforcements can affect R&D investment and patenting strategies. Does the recent increase in patent litigation reduce firms' incentives to innovate?

I aim to answer this question with a model of patent infringement suits that leads us to understand the determinants of patent litigation and various court outcomes, and to investigate how these outcomes affect the firms' investment levels for innovation. An effective environment for innovation requires certainty and efficient court outcomes (e.g. early settlements, granting a preliminary injunction for valid patents). Uncertainty about court outcomes increases the duration of disputes and causes higher transaction costs for both parties engaged in a lawsuit. Litigation costs prevent litigants from executing effective R&D which is detrimental to technological

progress. Bessen and Meurer (2005) assert that "the annual expected cost of patent disputes to a firm varies proportionally with the firm's hazard rate of entering disputes", all else being equal. They state that "firm litigation hazards provide a baseline indicator of the changing effect of litigation on innovation." The firms' hazard to patent litigation may be increased by the number of inventions and therefore by the number of patents. The cost of patent litigation may be offset by greater benefits of generated patents. Similar to Bessen and Meurer (2005), to evaluate the possibility of such compensating benefits, I decide to gain a comprehensive analysis of the likelihood of litigation and various court outcomes.

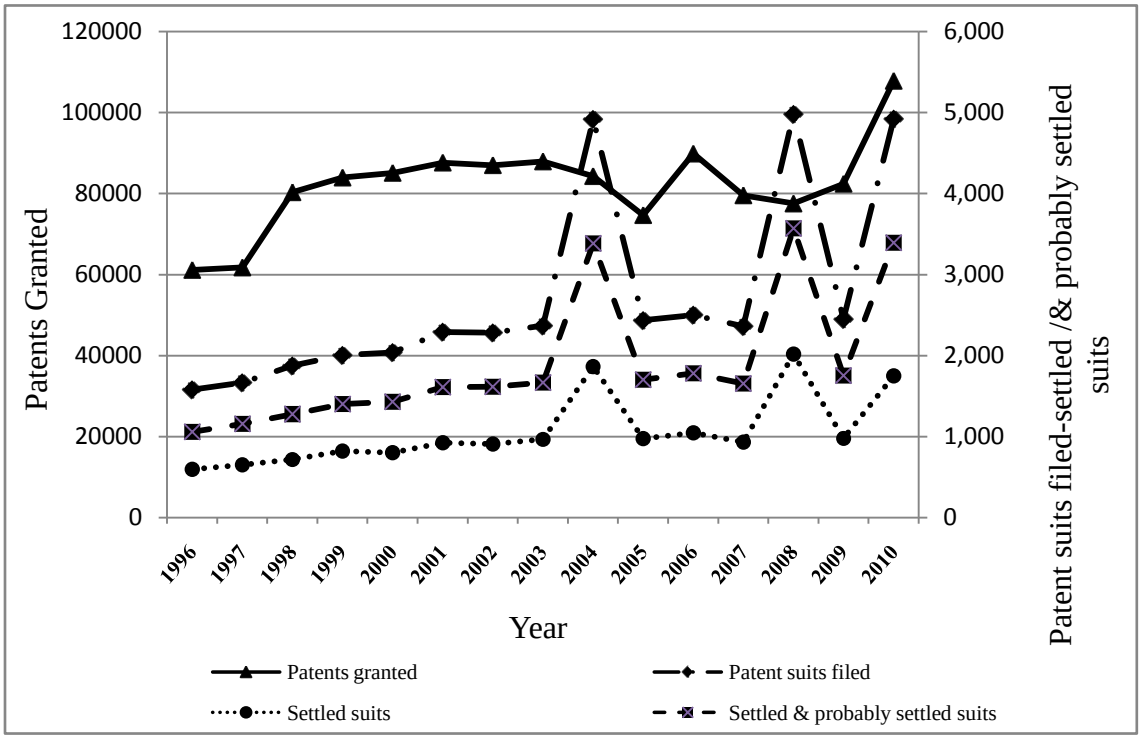

Figure 1.1 Patent Suits and Patent Settlement Outcomes in U.S. Courts from 1996 to 2010

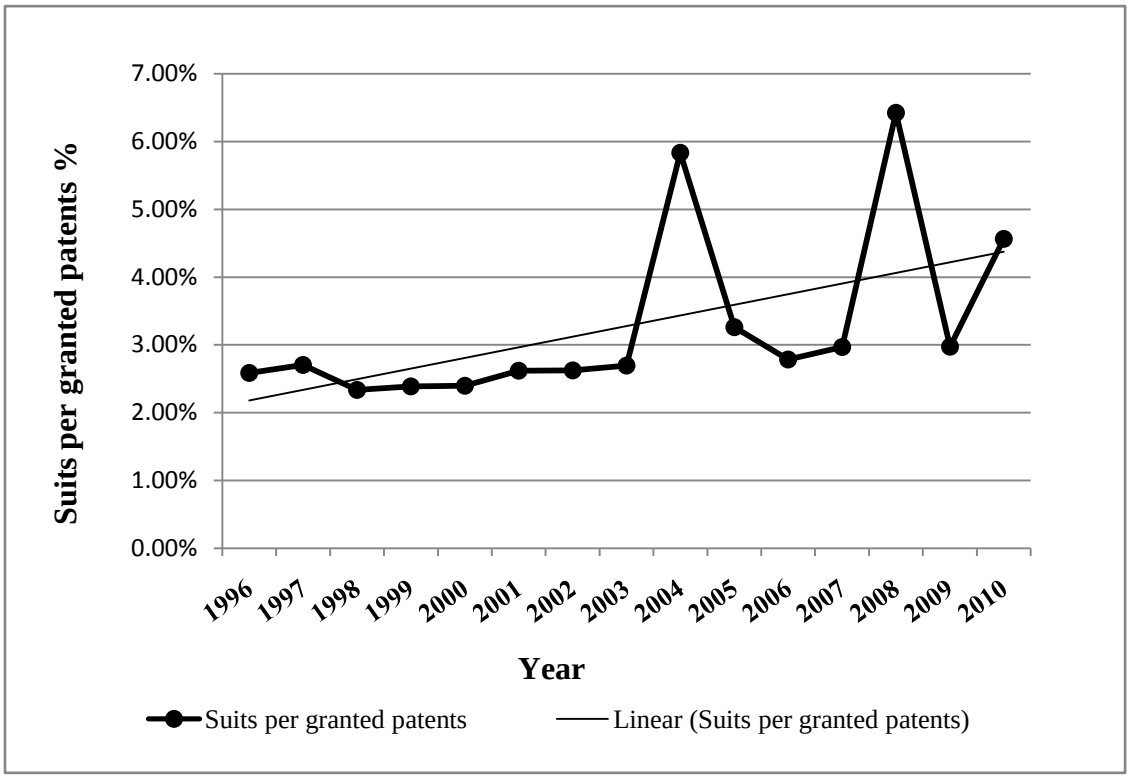

Figure 1.2: Patent Suits Filed per Granted Patents by the USPTO Office Annually

Figure 1.2 shows the trends in the annual rate of patent suits filed per granted patents by the United Sates Patent and Trademark Office (USPTO). Obviously, there was a positive trend from 1996 to 2010 in filed patent suits per granted patents which was the primary motivation to find the main determinants of patent litigation. I present a decision model that identifies the main determinants of patent litigation and various court outcomes for both plaintiffs or "patentees" and defendants or "alleged infringers." I conduct my empirical analysis at two levels: (1) separately for each litigant in separate models and (2) combining both plaintiffs' characteristics together with defendants' characteristics in a single model. This analysis provides an estimate of the contribution of each factor to filing a lawsuit and various court outcomes at each stage of the litigation process. I provide strong evidence that demonstrates that the rapid

increase in patent litigation can be explained by increases in firm values for the number of patents per dollar of R&D spending, capital expenditures, total R&D spending, market value, scale, liquidity level, and patent portfolio quality (measured by originality, generality, and citations). I conclude that both litigants' characteristics and patent characteristics are the important factors driving an increase in the litigation rate. My results also represent that the influential determinants of cooperative solutions via settlement mechanism are capital intensity, R&D intensity, scale, liquidity level, patenting rate and the quality of patent portfolio. Similar factors with different magnitudes, particularly with the respect to measures of patent portfolio quality, drive the granting of preliminary injunctions by the courts.

I provide strong evidence that the likelihood of an injunction will be higher for patent portfolios having a high score of generality and a low score of originality. These measures of patent quality demonstrate that only invaluable patents are more likely to win and to receive an order of injunctive relief. My findings suggest that the dominant determinant of the probability of going to trial court is litigant’s scale. Major patentees impose more stakes to smaller defendants by refusing to settle a dispute prior to trial. Large plaintiffs look for a winning opportunity at trial in order to receive damage awards or ask for higher settlement transfer during the trial process before final verdict.

Similar to injunction results, plaintiff win rates proportionally increase with the quality of patent portfolios. Both litigants' characteristics and patent characteristics are the dominant factors driving the likelihood of winning for the plaintiffs. There are two reasons that explain why plaintiffs win at trial and receive damage awards: (1) plaintiff’s capability to better handle litigation costs than defendants, and (2) having a higher- quality patent portfolio enables plaintiffs to better defend infringed patents.

Lanjouw and Lerner (2001) assert that reputational considerations of litigiousness could explain the relationship between financial characteristics of litigants and court actions. Lanjouw and Schankerman (2004) provide evidence that there are substantial differences in litigation rates by the size of litigants. Lanjouw and Lerner (2001) state that "the importance of creating and maintaining a reputation for litigiousness may increase when a firm expects to be engaged in future disputes." Larger firms have more patents and therefore they expect greater involvement in patent litigation. Eisenberg and Farber (1997) investigate "the frequency of trials and plaintiff wins" and examine data on these outcomes in a larger number of civil suits filed in federal courts. They assert that the process through which suits are selected is not based on random selection. They believe that the *case selection* which leads to lawsuits depends on the expected monetary value of the claim and also on the pecuniary and non-pecuniary costs of litigation. The lower litigation cost implies higher trial rates by plaintiffs, and plaintiffs with lower litigation costs file suits that have a lower probability of winning at trial.

I present a selection model, motivated by Eisenberg and Farber (1997), to investigate how the selection process affects litigants' characteristics in suits filed in relationship to the distribution of patentees. I conduct my empirical analysis at two levels for minor and major patentees: (1) in a base model which includes plaintiffs 'characteristics and their patents' characteristics, and (2) in a full model by adding defendant’s characteristics to the base model. The central theme in my analysis is that

the cases are selected for suit systematically based on the plaintiff's taste for greater engagement in a legal dispute. Plaintiffs are drawn from those corporations with the "highest taste for litigation" (lowest cost of litigation), conditioned on the positive expected value of a lawsuit.

Similar to Eisenberg and Farber (1997), the key to my empirical tests is the identification of a pool of lawsuits that were drawn from distributions with different levels of dispersion in litigation costs. Two groups of plaintiffs—minor patentees versus major patentees—have varying dispersion in the distribution of their litigation costs. There is substantial variation across minor patentees with regard to their taste for litigation in comparison with major patentees. These variations in litigiousness lead to the variation in the distribution of litigation costs. These costs are not only legal costs, but also credit costs, due to bankruptcy risk, and business costs. Bessen and Meurer (2005) assert that "business can be disrupted as managers and researchers spend their time producing documents, testifying in depositions, strategizing with lawyers, and appearing in court."

I implement my models empirically using the reasonable assumption that the distribution of litigation costs for minor patentees has a greater *percent variation* than the distribution of litigation costs for major patentees. Minor patentees have relatively fewer decision makers, and they are more likely to be the largest shareholders, which increases the variation of taste for litigation engagement. On the other hand, major patentees are more systematically involved in the decision-making process and have

lawyers who regularly handle the large pool of their disputes. Eisenberg and Farber (1997) argue that one property of any reasonable model for the litigation process is that lower litigation costs will translate to higher trial rates. Based on this argument, I support the idea that patentees with lower litigation costs are willing to file suits in which they have a smaller probability of winning at trial. I conclude that suits filed by pools of potential plaintiff with greater dispersion in the distribution of their litigation cost will have lower plaintiff win rates and lower rates of granted injunctions. I also conclude that patentees with portfolios of higher-quality patents are more likely to win a lawsuit and more likely to receive a preliminary injunction than other patentees. I find that the results that are generally consistent with the implications of the selection model.

My analysis differs from previous literature (e.g. Lanjouw and Schankerman, 2004; Lerner, 2010) in that the unit of analysis in my research is litigants rather than the patent. Similar to Bessen and Meurer (2005), my aim is to discover how the plaintiff's choices at different stages of the litigation process affect litigation rates and various court outcomes. Many prior studies have examined how the characteristics of litigants and patents affect the probability of filing a lawsuit, but combining both plaintiff's and defendant's characteristics together with patent characteristics in a single model has not yet been attempted, to my knowledge. The models developed provide a multi-factor framework of firm litigation behavior that permits ex-ante risk assessment of litigation and its outcomes.

I present a selection model, for the first time in the context of patent litigation suits, to investigate how the selection process affects litigants' characteristics in suits filed in relation to the distribution of patentees. I then develop specific implications for trial rates, plaintiff win rates, injunction rates, and settlement rates among minor and major patentees and I examine data on these outcomes in a large number of civil suits filed in federal courts.

The empirical results section in chapter 4 first document trends in patent litigation outcomes from 1996 to 2010 and shows how court outcomes differ by years and by industry groups. Secondly, I present a framework for testing two types of models—the decision model and the selection model—to explain the behavior of plaintiffs and defendants during the patent litigation process. Although proposed models have a similar specification, they are different in nature. A *decision model* examines the determinants of patent litigation and various court outcomes whereas a *selection model* investigates how the selection process affects litigants' characteristics in suits filed in relation to the distribution of patentees.

This dissertation is organized as follows: Chapter 2 reviews the literature; Chapter 3 explains conceptual models, hypotheses, data and methodology; Chapter 4 shows an empirical analysis of patent litigation outcomes Chapter 5 reports empirical results for decision models and selection models; and Chapter 6 concludes.

Chapter 2

LITERATURE REVIEW

2.1 Theoretical Framework

Cooter and Rubinfeld (1989) develop the chronology of typical legal disputes and match up stages in legal disputes with economic modeling. In the first stage of a dispute, one person (injurer) harms another (the victim). The frequency of harm is affected by decisions that people make to take greater precaution to lower the social cost of the harm. As a result, economic efficiency requires balancing the cost of harm against the cost of preventing it. In the second stage, Cooter and Rubinfeld (1989) explain that " the party that suffered harm decides whether or not to assert a legal claim." A rational self-interested person makes this decision by comparing the expected future benefit of filing a lawsuit versus its expected costs. After a legal claim is asserted, in the third stage, parties "attend preliminary hearings with the judge, engage in pretrial discovery, and set trial dates." The court objective is to encourage parties to bargain to settle their disputes. The result of the bargaining game can be either a cooperative solution which leads to a settlement or a non-cooperative solution which leads to trial. Another feature of bargaining is the negotiators, who are lawyers. Sometimes their interests are not identical to their clients' interests. This leads to the principle-agent problem. The law encourages parties to resolve their disputes by

bargaining, and when negotiations fail, the court dictates a resolution in the fourth stage of a legal dispute, which is a trial. Cooter and Rubinfeld (1989) assert that parties view trials as "negative-sum games" in which the sum of winnings (positives) and losses (negatives) is negative. This supports the fact that trials are costly. They mention two products of adjudication: dispute resolution and rule making. From a private viewpoint, trials are a method of resolving disputes between parties. However, from a social viewpoint, trials are a collective choice mechanism for creating laws to regulate society.

Lanjouw and Schankerman (2004) explain two main models: "divergent expectations (DE) and asymmetric information (AI)." They assert that in DE models, "each party estimates the quality of his case with error (equivalently, the relevant court decision standard), and cases go to trial when one party is sufficiently more optimistic than the other. This occurs most often when true case quality is near the court's decision standard, and this selection mechanism drives the plaintiff win rates toward 50 percent." Lanjouw and Schankerman (2004) further explain AI models. They assert that "the probability that the plaintiff will win is private information. An uninformed party makes a settlement offer (or a sequence of offers) that is accepted by the informed party only when he has a low probability of winning at trial. Trials arise in (separating) equilibria because settlement offers have some probability of failing owing to the information asymmetry. This one-sided selection mechanism predicts that the win rate for the informed party should tend toward 100 percent." They state that

"trials arise in (separating) equilibria because settlement offers have a probability of failing owing to information asymmetry. This one-sided selection mechanism predicts that the win rate for the informed party should tend toward 100 percent." Lanjouw and Schankerman (2004) provide evidence which strongly favors the DE model for patent infringement suits.

Many scholars state that a rational, self-interested person will initiate a lawsuit if the initial cost of asserting a legal claim is less than the expected benefit of litigation. A rational decision maker will file a lawsuit if he expects a high possibility of settlement or a favorable court judgment (Eisenberg and Farber, 1997; Cooter and Rubinfeld, 1989; Shavell, 1982; Posner, 1986).

Most recent literature, on the economics of settlement, has migrated toward a game-theoretic framework in which there are information asymmetries and a variety of sequences by which settlement offers are made by the parties. Both parties have expected gains or losses regarding the size of settlement transfers in trial as well as the costs of a trial. These expected gains and losses represent the extent of the threat which could result in a cooperative solution (e.g., a settlement) or a non-cooperative solution (e.g., a trial).

Eisenberg and Farber (1997) assert that a potential claimant’s decision to file a lawsuit depends on the monetary expected value of the claim and the pecuniary and non-pecuniary costs of litigation. They not only consider the "pecuniary costs and costs due to risk aversion but also the psychological and emotional costs of confrontation."

They build a model in which the expected value of filing a suit is a function of (1) "the likelihood that the defendant would be found liable at trial", (2) "the expected damages that would be awarded at trial conditioned on a finding of liability", and (3) "litigation costs to both the plaintiff and the defendant." A potential claimant will file a lawsuit if the expected value of filing a suit is positive. They mention several properties of their litigation model. First of all, a potential claimant will file a lawsuit if the costs of litigation are low or if the expected value of litigation is positive. Secondly, there will be more trials when the costs of litigation are lower, conditioned on a lawsuit being filed. Thirdly, they mentioned that "where litigation costs are lower, potential claimants will be more likely to file claims in which they have a lower probability of prevailing."Eisenberg and Farber's model suggests that a potential plaintiff will be more likely to file a lawsuit if the cost of litigation is low, ceteris paribus. This means that a potential plaintiff will decide to file a lawsuit if the expected value of the proceeding litigation is positive. I develop a model using the same logic and assumptions developed by Eisenberg and Farber (1997).

2.2 Patent Litigation and Post-Suit Settlement

Cook (2007) reports that the number of patent suits filed in U.S. federal courts has approximately doubled during the 1997-2007 period. Cook (2007) examines the "friendly court hypothesis and the hypothesis of an increase in research productivity." He states that "the increased application of computers has led to increases in research

productivity", and therefore more patent grants and subsequently more patent litigation.

Under the "friendly court hypothesis", Cook expects that trial court outcomes have been affected by the establishment of the Court of Appeals for the Federal Circuit (CAFC) which was the sole court of appeal for patent suits in late 1982. He mentioned that "it could be that a court more ‘friendly’ to the patent holder led to an increase (either directly or indirectly) in patent suits, particularly infringement suits, by increasing firms’ incentives to file for patents." Cook (2007) shows a significant relationship between court outcomes and the amount of litigation excluding the effect of patenting activity (increase in number of patents granted by the USPTO). However, Kortum and Lerner (1998) reject the "friendly court" hypothesis and express that the increase in patenting grants can be a result of "technological opportunity."

Galasso and Schankerman (2010) investigate "how the fragmentation of patent rights and the establishment of the CAFC in 1982 affected the length of patent infringement disputes." They state that "licensing negotiations are shaped both by the characteristics of the patents and disputants, and by the legal environment within which negotiations take place." Their empirical findings suggest that "patent disputes in U.S. district courts are settled more quickly when infringers require access to fragmented external rights." They interpret the number of required patents, for a given technology, as "a measure of the degree of fragmentation of patent rights."

Lanjouw and Schankerman (2004) studied the determinants of patent suits and post-suit settlement suits. Their findings suggest that "litigation risk is much higher for patents that are owned by individuals and firms with small patent portfolios." They also state that "having a larger portfolio of patents reduces the probability of filing a suit." They predict that domestic patents have "lower costs of detecting and prosecuting infringements in the United States relative to the cost of settlement." As a result, domestic patent owners have higher litigation rates than foreign patentees. They also discover that "firms operating in the more concentrated technology area (that is, where patenting is dominated by fewer companies) are much less likely to be involved in patent infringement suits." These firms most likely have greater incentives for settlement.

Lanjouw and Schankerman (2004) state two main mechanisms to help plaintiffs settle their dispute without litigation. The first mechanism is by trading intellectual property in a different form, such as cross-licensing agreements, patent exchanges, and balancing cash payments. The second mechanism is by the expectation of repeated interaction among patentees. The repeated interaction in the theory of super games increases both the ability and the incentive to cooperatively settle a dispute without filing suits. They state that patent owners, who are relatively larger than disputants, are less likely to resort to litigation.

Lanjouw and Schankerman (2001b) state that the probabilities of litigation differ substantially among the various technology fields such as chemicals, software,

biotechnology, drugs and non-drug health patents, and are systematically related to patent characteristics and characteristics of their owners. They asset that "heterogeneity of patents, and their owners, is a central issue for the enforcement of intellectual property rights and its economic consequences." They conclude that "the process of enforcing patent rights is sorting among patent disputes." This sorting can occur at each stage of the legal process from filing a lawsuit, settling a dispute before or after trial court, or pursuing to trial court. Their findings suggest that first of all, most settlements occur quickly after the suit being filed, and secondly, post-suit settlements are high, at about 95 percent.

Lerner (1999) estimate the number of Massachusetts patent suits from January 1990 to June 1994 by using sample consists of 530 biotechnology firms. His findings suggest that six suits per hundred patents held by those firms will be litigated. Lerner (1999) concludes that "patents in new technologies, such as biotechnology, are more likely to be litigated than those in mature fields because there is more uncertainty about case outcomes." Lerner (2010) investigates the identity of defendants in the financial patent lawsuits. He asserts that "larger firms should have lower litigation costs because of learning curve effects". However, larger firms are more vulnerable to damage and reputation from an adverse judgment. He employed several proxies to measure litigation costs such as the firm's experience, the firm’s assets, financial conditions, leverage, location of headquarters, the extent of innovations by a firm, the extent of other innovations in the firm’s ZIP code, and academic connectedness. These proxies

are all exogenous variables in his model while the number of filings in all patent lawsuits for the firm as a defendant is an endogenous variable. His findings suggest that financial scale is the strongest determinant of being a target as a defendant.

Similar to Lerner (1999) and Lanjouw and Schankerman (2001b), I employ patent characteristics and litigants' characteristics in my models, and provide strong evidence that probabilities of litigation and various court outcomes are systematically related to the heterogeneity of patents and the parties involved in a lawsuit.

2.3 Trial and Post Trial Outcomes

Lerner (2010) investigates the litigation of patents related to financial products and services. He finds that financial patents are litigated at a rate 27-39 times greater than the rate of patents as a whole. He mention four criteria that can increase the probability of a trial: "(1) the likelihood that the offense is detected by the potential plaintiff, (2) the size of the stake under dispute, (3) the uncertainty about the outcome of the controversy between the two parties, and (4) the cost of settlement relative to that of trial." These criteria are consistent with Lanjouw and Lerner's (1996) findings that the probability of a trial increases when there is more uncertainty.

Eisenberg and Farber (1997) empirically model "the frequency of trials and plaintiff wins" and examine data on these outcomes in a larger number of civil suits filed in federal courts. They conclude that case selection that leads to lawsuits depends on the expected monetary value of the claim and also on the pecuniary and non-

pecuniary costs of litigation. The lower litigation cost will lead to higher trial rates. They argue that plaintiffs with lower litigation costs may be willing to file suits that have a smaller probability of winning at trial. They also argue that plaintiff win rates are negatively related to the variation in the distribution of plaintiffs' litigation costs in the population of potential claims. They also present predictions about the identity of the plaintiff which indicates that trial rates will be higher for the individual plaintiff rather than the corporation plaintiff. They also conclude that lower plaintiff costs lead to higher trial rates and lower plaintiff win rates. In their findings, the plaintiff win rate is lower for the individual plaintiff compared to the corporation plaintiff. They find that high trial rates are associated with low plaintiff win rates.

I empirically model the frequency of various court outcomes such as injunction rate, settlement rate, trial rate, and win rate. Similar to the Eisenberg and Farber (1997), my empirical hypotheses stem from differences in the variation in the distribution of costs and not from differences in the level of costs. Based on the primary hypothesis that the distribution of litigation costs for minor patentees has more *percent variation* than the distribution of litigation costs for major patentees, and the fact that lower litigation cost leads to higher trial rates, I test whether trial rates will be higher for suits in which a plaintiff is a minor patentee than for suits in which the plaintiff is a major patentee. Where the plaintiff's litigation costs are lower for small corporations, the average quality of filed suits will be lower among all lawsuits, which results in a lower plaintiff win rate for small corporations. Therefore, I hypothesize

that the plaintiff win rates and injunction rates will be lower for suits in which the plaintiff is a minor patentee than for suits in which the plaintiff is a major patentee.

2.4 Preliminary Injunctions

Preliminary injunctions have become an important feature of litigation in the federal and state courts. A preliminary injunction may be requested by plaintiffs shortly after a lawsuit has been filed. Lanjouw and Lerner (2001) assert that "many settlements occurred between the request for a preliminary injunction and the hearing on the motion or after the plaintiff threatened to file such a request." They state four criteria reviewed by courts before granting a preliminary injunction:

> "1. Whether the party requesting the injunction (typically the plaintiff) has no adequate remedy at law or faces the threat of irreparable harm if the injunction is denied;
>
> 2. The balance between this harm and the injury that granting the injunction would inflict on the defendant;
>
> 3. The probability that the plaintiff will win the case on the merits; and
>
> 4. The public interest."

An issuance of a preliminary injunction by the court can be costly and harmful to the defendants. Bessen et al. (2011) assert that "preliminary injunctions can shut down production and sales while the litigation pends. Even without a preliminary

injunction, customers may stop buying a product." This is due to the lawsuit risk and the threat of the product being withdrawn from the market.

Lanjouw and Lerner (1996) provide evidence that financially secure plaintiffs use preliminary injunctive relief to prey on weaker firms by driving up their cost. They state that the probability of winning an injunction may be improved with greater expenditures on legal services, and larger firms with good financial security may spend more on such services. Small firms and individuals are less sophisticated in intellectual property disputes, and therefore have a lower probability of winning in court.

Lanjouw and Lerner (2001) assert that injunctions have substantial effects on the outcome of disputes. Many firms request preliminary injunctions not just to avoid "irreparable harm" but also to impose financial pressure on their rivals and create threat points in their market. If a plaintiff can shut down a significant portion of a defendant's operations for months or years while a dispute is being resolved, the defendant is likely to experience a significant reduction in operating cash flow. Moreover, an injunction itself imposes legal costs to continue a case through to the final ruling.

One of the studies of the preliminary injunctive relief model was done by Lanjouw and Lerner (1996). They investigate how the availability of preliminary injunctive relief affects the probability of suits going to trial and the impact of this legal remedy on high and low cost plaintiffs and defendants. Their findings indicate that preliminary injunction requests are more common in suits where the plaintiffs had greater sales than the defendant. They expect that patent awards in a new area of

technology such as software and biotechnology, with few prior patents, are more likely to be characterized by greater uncertainty. They also assert that patents in the subclass where awards are frequently reexamined are likely to be in areas with substantial legal uncertainty and therefore more litigated than other patents, and this affects the decision to request a preliminary injunction.

Lanjouw and Lerner's (2001) findings suggest that corporate plaintiffs have a larger level of cash and equivalents than defendants in suits in which a preliminary injunction was requested. They show that preliminary injunctions in patent suits tend to be used by large firms to impose financial distress on smaller rivals. They also assert that reputational considerations of litigiousness could explain the relationship between financial characteristics of litigants and court outcomes. The importance of constructing and maintaining a reputation for litigants may increase when a firm faces more litigation in the future. If requesting an order of injunctive relief contributes to a firm’s reputation for litigiousness, then there is a positive relationship between the firm size and requesting injunctions.

Many practitioners believe that the issuance of a preliminary injunction more than likely will lead to a permanent injunction at trial, and therefore, for plaintiffs, the granting of a preliminarily injunction is equivalent to a win at trial. Similar to the win rate hypothesis, I hypothesize that major patentees are more likely to win an injunction than minor patentees.

2.5 Patent Characteristics

The literature (Lanjouw and Schankerman, 2004; Bessen and Meurer, 2005; Lerner, 2010; Hall et al., 2005; Hall and MacGarvie, 2010; Lai and Che, 2009; Harhoff et al., 1999; Harhoff et al., 2003; Jaffe and Trajtenberg, 2002; and Lanjouw et al., 1998) suggests that the value of patents can indirectly be measured by patent characteristics. Patent value can be captured through the number of claims made in the issued patent, the number of forward citations (future citations received by a patent), and the number of backward citations (the number of prior patents cited in patent documents). The patent litigation literature suggests that valuable patents have a higher expected benefit of litigation and therefore will be more frequently litigated.

Hall et al. (2005) confirm that patent citations, R&D intensity, and patent yield contain significant information on the market value of the firm. They find that an extra citation per patent boosts a market value by 3%. Lanjouw and Schankerman (2004) also use citations, along with other measures such as the number of claims, nationality of patent owner(s), technology field, patent portfolio size, relative size of potential disputants and ownership to determine the probability of litigation. They conclude that the probability of litigation increases with respect to the number of claims and forward citations. Their findings suggest that the likelihood of a suit falls with respect to the number of backward citations per claim. This result is consistent with the view that backward citations are an indication that the patent is in an already well-developed technology area and so it's less likely to cause disputes. Evidence about backward

citations as a measure of patent quality is ambiguous. Lanjouw and Schankerman (2004) find that backward citations per claim are negatively correlated with litigation probability. However, Lerner (2006) found that backward citations in financial patents are positively correlated with litigation. Harhoff and Reitzig (2004) have found evidence on the association between backward citations and patent litigation. These studies found that backward citations (as a proxy for value) are positively correlated with the rate of litigation.

Hall and Ziedonis (2007) investigate the litigation of patent lawsuits in 136 semiconductor firms. They explore the relationship between litigation probability, as a dependent variable, and patent portfolio size, firm level characteristics, and patent propensity, all as independent variables. Their findings suggest that the probability of being a target (the defendant in an infringement suit or the plaintiff in a validity suit) increases more rapidly with size and R&D intensity for semiconductor firms than for other firms.

One of the studies of the patent valuation model was conducted by Lai and Che (2009). They studied patent infringement lawsuits in U.S. district courts and proposed an integrated evaluator for patent management. They set the damage award as the endogenous variable and 17 patent indicators as the exogenous variables. Exogenous variables describe the quantitative features of a patent. These indicators are: the number of assignees and the number of inventors for each patent, the number of independent and dependent claims for each patent, U.S. patent references, foreign

patent references, non-patent references, forward citations, international patent classifications, U.S. patent classifications, worldwide patent families, U.S. patent families, the number of office opinions by the examiner of USPTO for each patent, the number of responses to USPTO by the assignee for each patent, the examination period, the number of drawings for each patent, and the patent life-span. The authors state that a linear relationship between the damage award and the patent indicators could not be modeled as a simple linear equation. Hence, they construct the Back-Propagation Neural Network model to evaluate patents. Their results are somewhat different from other scholars (e.g., Hirschey and Richardson, 2001; Hereof et al., 2003; Hirschey and Richardson, 2004; Von Wartburg et al., 2005; and Silverberg and Verspagenb, 2007).

Higher-quality patents have a higher certainty of patent validity and infringement at trial while lower-quality patents are more likely subject to invalidity or non-infringement rulings at trial. I employ forward citations, backward citations, and measures of generality and originality to my models to capture patent portfolio quality for plaintiffs. Where infringed patents are valuable, the quality of filed suits on average will be higher among all lawsuits which may result in higher plaintiff win rates and higher injunction rates. Therefore, I hypothesize that both plaintiff win rates and injunction rates will be higher for suits in which the plaintiff has more citations, a higher score of generality, and a lower score of originality, all else being equal.

In summary, similar to the Lerner (1999) and Lanjouw and Schankerman (2001b) studies, I employ patent characteristics and litigants' characteristics to my models. I argue that the probabilities of litigation and various court outcomes are systematically related to the heterogeneity of patents and parties involved in a lawsuit. I develop a model using several assumptions: first of all, a potential claimant will file a lawsuit if the expected value of litigation is positive; secondly, there will be more trials when the costs of litigation are lower, conditioned on a lawsuit being filed; and thirdly, where litigation costs are higher (lower), plaintiffs will be more (less) likely to file claims in which they have a higher (lower) probability of winning.

Moreover, by considering my primary hypothesis that the distribution of litigation costs for minor patentees has a greater *percent variation* than the distribution of litigation costs for major patentees, and the fact that lower litigation cost will imply higher trial rates, I argue that trial rates are higher for suits in which a plaintiff is a minor patentee than for suits in which a plaintiff is a major patentee. Where plaintiffs' litigation costs are lower for small corporations, the average quality of filed suits is lower among all lawsuits which results for lower plaintiff win rates and lower injunction rates for small corporations. Where infringed patents are valuable, the quality of filed suits, on average, will be higher among all lawsuits which may result in higher plaintiff win rates and higher injunction rates.

Chapter 3

MODEL, HYPOTHESES, DATA AND METHODOLOGY

3.1 Economic Model

I use a model developed by Eisenberg and Farber (1997). Eisenberg and Farber's model suggests that a potential plaintiff will be more likely to file a lawsuit if the cost of litigation is low, ceteris paribus, which means that a plaintiff only files a lawsuit if it may have a "positive expected value." The suit has some expected value to plaintiff, V_P as a function of the likelihood that the defendant would be found liable at trial, π, the expected damage at trial, D, the costs of litigation to the plaintiff, C_p, and the cost of litigation to the defendant, C_d. A potential plaintiff will decide to file a lawsuit if the expected value of proceeding with litigation is positive.

The expected value of filing a lawsuit by plaintiff is:

$$V_{P=}V_P(\pi, D,\ C_p, C_d) \tag{3.1}$$

The condition for filing litigation is:

$$V_P(\pi, D,\ C_p, C_d) \geq\ 0 \tag{3.2}$$

This condition is true during the patent litigation process after filing a lawsuit until adjudication at trial. The plaintiff will likely decide to go to the trial as long as the

above condition holds. The plaintiff will settle when the expected value of the court outcome is less than the settlement offer. The key properties of the model are:

1. V_P is monotonically decreasing in C_p

2. V_P is monotonically increasing in π

The first property implies that a potential plaintiff will decide to file a lawsuit if the litigation cost is less than some threshold value, C_p^*, where C_p^* is a function of $\pi, D, \text{and } C_d$.

$$C_p < C_p^*(\pi, D, C_d) \tag{3.3}$$

The threshold cost level positively correlates to the likelihood of liability (π) and the expected damages are conditional on a finding of liability at trial and the defendant litigation cost that may or may not be observable to the plaintiff. A simple conclusion suggests that plaintiffs with lower litigation costs will be more likely to file low- π and low- D suits.

The distribution of litigation costs among potential plaintiffs is defined as:

$$C_p = \mu + \sigma Z \tag{3.4}$$

Where Z is a random variable with a mean of zero and a variance of one. μ is the mean of litigation cost, which depends on the size of the case (π and D). The parameter σ is a scale parameter that determines the variance of the litigation cost distribution (σ^2). The parameter σ controls the dispersion of plaintiffs' litigation costs

in the population of potential plaintiffs without affecting the mean. The expected value of litigation costs conditioned on filing a lawsuit is:

$$\mathrm{E}(\mathrm{C}_p \left| C_p < C_p^* \right.) = \mu + \sigma \mathrm{E}(\mathrm{Z} \left| \mu + \sigma \mathrm{Z} < C_p^* \right.)$$

$$= \mu + \sigma \mathrm{E}\,(\mathrm{Z} \left| \mathrm{Z} < (C_p^* - \mu)/\sigma \right.)$$

$$= \mu + \sigma \mathrm{E}\,(\mathrm{Z} \left| \mathrm{Z} < \mathrm{Z}^* \right.) \tag{3.5}$$

Where

$$\mathrm{Z}^* = (C_p^* - \mu)/\sigma \tag{3.6}$$

The conditional mean is less than the mean of the unconditional distribution (μ) of costs. Thus, the average litigation costs among suits filed are less than average costs in the set of all potential plaintiffs.

Eisenberg and Farber also investigate the effect of the scale parameter σ on the conditional mean of litigation costs. The derivative of the conditional mean of the cost distribution with respect to σ is:

$$\frac{\partial \mathrm{E}(\mathrm{C}_p \left| C_p < C_p^* \right.)}{\partial \sigma} = \mathrm{E}\,(\mathrm{Z} \left| \mathrm{Z} < \mathrm{Z}^* \right.) - \frac{\partial \mathrm{E}\,(\mathrm{Z} \left| \mathrm{Z} < \mathrm{Z}^* \right.)}{\partial \mathrm{Z}^*} \mathrm{Z}^* \tag{3.7}$$

In appendix C, the result of equation 3.7 is derived. The results demonstrate that the derivative of the conditional mean of the cost distribution with respect to σ in equation A.4.5 is negative. This implies that an increase in the scale of the unconditional distribution of the plaintiff's litigation costs causes a reduction in the

average plaintiff's litigation costs. These results can be operationalized by considering two groups of litigants with the same mean litigation costs but different cost distributions and therefore different variances. The process of lawsuit selection among these groups yields different results. On average, where litigation costs are lower, litigants drawn from high-variance distribution will have lower litigation costs than litigants drawn from low-variance distribution. Based on this argument, I shape the following hypotheses:

- *Hypothesis 1: Trial rates[1] will be directly correlated to the dispersion in the distribution of patentees' litigation costs in the population of potential plaintiffs.*

Plaintiffs with lower litigation costs will be more likely to file a lawsuit in which they have a smaller chance of winning at trial. Where litigation costs are lower, the lower quality suits (lower π suits) will meet the criterion for filing, $\mathrm{C}_p < C_p^*(\pi, \mathrm{D}, \mathrm{C}_d)$. I can write the criterion for filing a lawsuit in terms of the probability that the defendant would be found liable at trial if π is greater than the threshold value, π^*. I add a new variable, θ, which is a proxy for "patent quality" to Eisenberg and Farber's model.

$$\pi > \pi^*(\mathrm{C}_p, \mathrm{D}, \mathrm{C}_d, \theta) \tag{3.8}$$

[1]Trial rates are not only correlated to the dispersion of plaintiffs' litigation cost but also filing a patent lawsuit is correlated to the dispersion of the plaintiffs' litigation cost.

Where plaintiff's litigation costs are lower, the minimum threshold for π is lower and the average quality of filed suits will be lower among all lawsuits which results in a lower plaintiff win rate, ceteris paribus.

- *Hypothesis 2: Patentee win rates will be negatively related to the dispersion in the distribution of plaintiff's litigation costs in the population of potential plaintiffs.*

In equation 3.8, θ is patent quality. Higher-quality patents have a higher certainty of patent validity and infringement at trial while lower-quality patents are more likely subject to invalidity or non-infringement rulings at trial. Where θ is higher, the minimum threshold for π is higher and the average quality of filed suits will be higher among all lawsuit cases which results in a higher plaintiff win rate, other things being equal. This hypothesis does not require the assumption of specific variations in the distribution of the plaintiff's litigation costs.

- *Hypothesis 3: Patentee win rates will be higher for suits with higher-quality patent portfolio, all else being equal.*

3.1.1.1 Proposed Empirical Test of the Model

The key to my empirical tests is the identification of the pool of lawsuits that were drawn from distributions with different levels of dispersion in plaintiff and defendant litigation costs. I argue that two groups of litigants, large firms or "major

patentees" versus small firms or "minor patentees", have different dispersion rates in the distribution of their litigation costs. There is substantial variation across small corporations in regard to their taste for litigation involvement (litigiousness) than large corporations. This variation in litigiousness leads to the variation in the distribution of litigation costs. It is important to emphasize that my empirical implications stem from differences in the variation in costs and not from differences in the level of costs.

Why do minor patentees have a greater variation in the *distribution of litigation costs than major patentees?*

First, there are many closely held corporations that are managed by their owners who have different attitudes regarding litigiousness (inverse of litigation costs). Similarly, small public corporations (minor patentees) have relatively fewer shareholders than large corporations and are more likely to be managed by the largest shareholders, on average. This increases the variations of decisions (a taste for litigiousness) during the patent litigation process for minor patentees, particularly with the respect to filing a lawsuit, settling a dispute or proceeding to trial. Large corporations (major patentees), however, are more systematically involved in decision making (less variation in litigiousness) during the litigation process.

Secondly, variations in the R&D investment level among small corporations lead to relatively greater variation in the quality of their patents. The greater variation in the quality of patents leads to greater variations in litigiousness (depending on the quality of patents) against infringed patents. Larger corporations, however, invest more

on R&D, on average, and have a greater quality of patents[2] (less variation in quality of patents) simply because of more resources for searching prior art[3]and the ability to prove patent novelty. These variations in the R&D investment level among small corporations bring about more variation in litigiousness, which lead to more dispersion in the distribution of litigation costs among small corporations than large corporations.

Thirdly, both legal costs and business costs affect litigants during the patent litigation process. Business costs of litigation can be volatile and varied among minor patentees. Bessen and Meurer (2005) assert that "business can be disrupted as managers and researchers spend their time producing documents, testifying in depositions, strategizing with lawyers, and appearing in court." These activities bring about more costs to small businesses if they decide to continue litigation. This implies that small corporations, on average, are exposed to more variations to bear business costs than large firms. Therefore, small firms may or may not be willing to bear business costs. This leads small corporations having a greater variation of the distribution of litigation costs than large corporations, on average.

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[2]Table 3.1 indicates statistics of patent characteristics for small and large plaintiffs as patentees. Most measures such as patenting rate, as well as forward and backward citations are significantly greater for major patentees than minor patentees. These measures are all proxies for patent quality and prove a high quality of patent portfolios among major patentees, on average.

[3] Prior art is all information that has been disclosed to the public in any form about an invention before a given date.

Fourthly, small firms (minor patentees) might see the threat of their credit cost increase because of bankruptcy risk possibly created by patent litigation or a threat of a preliminary injunction that will jeopardize their business by shutting down their production and sales. However, large firms (major patentees) with multiple lines of business could switch to production and sales of other products if an injunction is granted so they are more stable than small firms. As a result, small firms are more affected by injunctions and bankruptcy risk than larger firms, which leads to a greater variation of defensive strategies, and therefore a greater variation of the distribution of litigation costs among minor patentees.

The focal point of my assumption is that *on average,* minor patentees are more likely than major patentees to have greater variation in litigiousness, which leads to a greater variation in the distribution of litigation costs for minor patentees than for major patentees.

3.2 Empirical Hypotheses

My empirical hypotheses stem from differences in variation in the distribution of costs and not from differences in the level of costs. Based on primary hypotheses developed in the economic model section, I can restate my hypotheses in terms of characteristics of plaintiffs with the respect to scale and patent quality:

- *Hypothesis 1: Trial rates will be higher for suits in which the plaintiff is a minor patentee than for suits in which the plaintiff is a major patentee.*

Where a plaintiff's litigation costs are lower for small firms, the average quality of filed suits will be lower among all lawsuits, which results in lower plaintiff win rates for small firms (minor patentees).

- *Hypothesis 2a: Plaintiff win rates will be higher for suits in which the plaintiff is a major patentee than for suits in which the plaintiff is a minor patentee.*

Lanjouw and Lerner (2001) assert that reputational considerations of litigiousness could explain the relationship between financial characteristics of litigants and court actions. They believe that importance of constructing and keeping a reputation for litigiousness may increase when larger firms expect more litigation in the future. Larger firms are more likely expecting to be involved in patent infringement since they have more patents. If requesting an order of injunctive relief contributes to a firm's reputation, then there is a positive relationship between the firm size and requesting injunctions. Many practitioners believe that an issuance of a preliminary injunction is more likely to lead to a permanent injunction at trial, and therefore, for plaintiffs, the granting of a preliminarily injunction is equivalent to a win at trial. Similar to hypothesis 2a, I can hypothesize that larger firms (major patentees) are more often granted an order of injunctive relief than small firms (minor patentees).

- *Hypothesis 2b: Injunction rates will be higher for suits in which the plaintiff is a major patentee than for suits in which the plaintiff is a minor patentee.*

Lanjouw and Schankerman (2004) provide evidence that the probability of litigation increases with respect to the number of claims and forward citations. Their

findings suggest that the likelihood of a suit falls with the number of backward citations per claim. Evidence regarding backward citations as a measure of patent quality is ambiguous. Lanjouw and Schankerman (2004a) find that backward citations per claim are negatively correlated with litigation probability. However, Lerner (2006) found that backward citations are positively associated with litigation in financial patents. Harhoff and Reitzig (2004) have found evidence on the positive correlation between backward citations and patent litigation. All of these studies, except Lanjouw and Schankerman (2004a), found that backward citations (a proxy for patent value) are positively correlated with the litigation rate.

I expect litigated patents to be much more frequently cited than randomly chosen patents. Clearly, patent holders will be more likely to file a lawsuit to obtain a damage award if the number of forward citations and the number of claims for a patent are high. Similarly, I expect patent holders to be more likely to file a lawsuit if backward citations, as a proxy of patent value for a patent, are high. There are two measures of generality and originality that show the influence of patents. These measures tend to be positively correlated with backward citations (for originality) or forward citations (for generality). Highly cited patents have higher generality scores, and patents that make lots of citations have a higher originality. A high generality score suggests that the patent influenced subsequent patents in the various fields and had an extensive impact on the subsequent innovation. As a result, valuable patents have a high score of generality and a low score of originality.

In equation 3.8, θ is "patent quality." Higher-quality patents have a higher certainty of patent validity and infringement at trial while lower-quality patents are more likely subject to invalidity or non-infringement rulings at trial. Where θ is higher, the minimum threshold for π is higher and the average quality of filed suits will be higher among all lawsuits. This result in higher plaintiff win rates and higher injunction rates, other things being equal. This hypothesis does not require the assumption of specific differences between minor and major patentees.

- *Hypothesis 3a: Plaintiff win rates will be higher for suits in which the plaintiff has a higher-quality patent portfolio (more citations, a high score of generality, and a low score of originality), all else being equal*

- *Hypothesis 3b: Injunction rates will be higher for suits in which the plaintiff has a higher-quality patent portfolio (more citations, a high score of generality, and a low score of originality), all else being equal*

In summary, my empirical hypotheses stem from differences in the variation in the distribution of costs and the fact that minor patentees have greater variation in the distribution of litigation costs than major patentees. As a result, plaintiffs with lower litigation costs (minor patentees) are more likely to file a lawsuit (higher trial rates) in which they have a smaller chance of winning at trial (lower win rates at trial). Similarly, injunction rates will be lower for suits in which the plaintiffs are minor

patentees. Finally, plaintiff win rates and injunction rates will be higher for suits in which the plaintiff has a higher-quality of patent portfolio regardless of its scale.

3.3 Data

3.3.1 Construction of Data Set

I matched records from three databases: lawsuit filings from the Federal Judiciary Center (FJC), financial information from Compustat database of U.S. public firms maintained by the Wharton Research Data Services (WRDS), and patent data from the United States Patent and Trademark Office (USPTO) made available by the National Bureau of Economic Research (NBER). The data on the outcomes of patent litigation is from the Federal Judiciary Center (FJC[4]), which includes observations for each case filed with information on awards, filing and termination dates, the parties involved in a case, whether an injunctive relief was granted, and other court outcomes. This data set spans over 15 years from 1996 to 2010 and consists of 45,814 observations.

[4]Appendix D represents the *user agreement* that allow us to use restricted data from the Federal Court Case: Integrated Data Base from 1970 through 2009.

In the first step, to explore the characteristics of firms involved in a lawsuit, I matched the litigant parties reported in the FJC database with the Compustat database of U.S firms. The Compustat database which consists of firms' financial information from 1996 to 2010 is maintained by the Wharton Research Data Services (WRDS). I removed duplicate records involving the same lawsuit, with the same docket number, the same section numbers and in the same filing year. In the second step, I matched the resulting database with U.S. patent data from 1979 to 2006 provided by the National Bureau of Economic Research (NBER) by using the gvkey number as a unique identifier for each firm.

I use various samples in my dissertation. Figure 3.1 explains the formation and usage of generated samples at each stage of my analysis. Initially, the patent data consisted of 45,814 patent lawsuits. I deleted suits that were transferred to other districts, transferred to U.S. Agency, or were remanded, or reported as a "statistical closing." The resulting sample was reduced to 40,678 observations. I matched the Federal Judicial Center (FJC) database with Compustat, provided by the Wharton Research Data Services (WRDS), based on the names of firms for at least one of the litigants involved in a lawsuit either as a plaintiff or as a defendant. The resulting sample size was reduced to 11,583, of which 5,471 were plaintiff parties and 6,112 were defendant parties. I also generated the samples from both identified defendants and plaintiffs, which contained both the defendant's and the plaintiff's financial

characteristics together with court outcomes for each lawsuit. This sample consists of 1,880 observations of pairs of firms for each case involved in patent infringement.

I also generated the "non-litigants sample" of firms from the population of all U.S. public corporations randomly selected from Compustat. For each litigant, a non-litigated firm was chosen randomly with the same SIC code and the same filing year. The comparisons between litigated firms and non-litigated firms help to control both the technology and cohort effects. The mean of the litigants' and non-litigants' samples characteristics are provided in Appendix B.2.

Finally, I matched the resulting sample, including the non-litigants' sample, with U.S. patent data from 1979 to 2006 provided by the National Bureau of Economic Research (NBER) by using gvkey number as a unique identifier for each firm. The resulting sample size was reduced to 5,101 for identified plaintiffs, 5,007 for identified defendants, and 2,876 for both plaintiffs and defendants.

I randomly selected a number of parties involved in a lawsuit to check the validity of matched data. I manually checked generated databases using Bloomberg Law and LexMachina for each suit. The rate of those falsely matched was less than 3% (8 out of 300 litigants).

My analysis differs from previous literature (e.g. Lanjouw and Schankerman, 2004; Lerner, 2010) in that I use the litigant as the unit of analysis rather than the patent as the unit of analysis. Similar to the Bessen and Meurer (2005), my aim is to discover how the plaintiff's choices at different stages of the litigation process affect

litigation rates and how parties are affected by litigation risks. Many prior studies have separately examined how the characteristics of litigants and patents affect the probability of filing a lawsuit and other court outcomes; however, combining both plaintiffs' and defendants' characteristics together with patent characteristics in a single model has not been attempted. The models developed provide a multi-factor framework of firm litigation behavior that permits ex-ante risk assessment of litigation and its outcomes.

Filter/Merge	**Number of suits**	**Data sources**	**Tables/Figures**
Initial sample	45,814	Federal Judicial Center (FJC)	
Deleted suits if transferred to other districts, remanded, or statistical closed (disposition codes*: 0,1,10, 11, & 18)	40,678	FJC	Figures1.1, 1.2; Tables 4.1- 4.7
Merge with Compustat database: Litigants sample			
Identified plaintiffs	5,471	FJC &Compustat	Tables 4.8, 5.4, A.4
Identified defendants	6,112	FJC &Compustat	Tables 4.8, 5.3,A.4
Identified plaintiffs & defendants	1880	FJC &Compustat	Table 5.5
Non-litigants sample			
Non-litigated sample for plaintiffs	5471	FJC &Compustat	Tables 5.4, A.4
Non-litigated sample for defendants	6112	FJC &Compustat	Tables 5.3, 5.5, A.4
Merge with U.S. patent data from USPTO			
Identified plaintiffs including non-litigants sample	5101	FJC, Compustat, & USPTO	Tables 4.9, 4.10, 5.1, 5.6 - 5.14, A.3
Identified defendants including non-litigants sample	5007	FJC, Compustat, & USPTO	Tables 5.7 - 5.13
Identified plaintiffs & defendants including non-litigants sample	2876	FJC, Compustat, & USPTO	Tables3.1, 5.2, 5.7 - 5.13, 5.15
***** Table A.1 explains suits disposition codes			

Figure 3.1: Formation and Usage of Generated Samples at Each Stage of Analysis

3.3.2 Sample Characteristics

Table 3.1 indicates estimated means of variables for a firm's years using both identified plaintiffs' and identified defendants' samples, including non-litigants' samples. The first column indicates all observations for all plaintiff firms while the second and third columns differentiate between small plaintiffs (if employment size < 500) and large plaintiffs (if employment size ≥ 500). The average number of personnel in the small corporations is 188 employees, while this number increases to 31,644

employees for large corporations. Due to this huge scale difference, size effects will be essential to determine the variation in litigiousness which leads to a variation of the distribution of litigation costs among large and small firms.

As statistics suggest, patent infringement is very common among large and R&D intensive firms. Average R&D spending for small plaintiffs is $11.8 million; while the average of R&D spending for large plaintiffs is $827.7 million. Larger firms, on average, invest seventy times more on R&D than small firms.

Patent litigants—both defendants and plaintiffs—tend to have a diverse current ratio (current assets divided by current liabilities) across their size. Current ratios for small and large firms as plaintiffs are 5.6 and 2.3, respectively. Small plaintiffs have more than twice the liquidity capacity to pay their debts, including litigation costs, than large corporations. The liquidity capacity for small firms may raise their litigious intention for filing patent litigation. As a result, small firms, as plaintiffs, have a greater variation in the distribution of litigation costs than larger firms, depending on their liquidity level.

It's interesting to see that small plaintiffs file lawsuits against defendants of a larger scale, on average. Alleged infringers, on average, have about 5,876 employees and spend $144.1 million on R&D, on average. Therefore, defendant firms do not avoid R&D spending per se by infringing on a firm's patent. One likely reason is explained by Bessen and Meurer (2005). They argue that "defendants in patent lawsuits are not merely copying to avoid spending R&D or only spending as necessary to invent

around patents." Bessen and Meurer also state that "poorly defined and uncertain patent boundaries make orderly processes of clearance and licensing too difficult."

Alleged infringers facing large plaintiffs spend, on average, about 572.8 million on R&D compared to $827.7 million R&D spending by plaintiffs. Both parties spend huge amounts on R&D which suggest that patent infringement could not be happening to avoid R&D *per se*. One reason could be a failure of the patent system in clearing patent boundaries before granting a patent.

The average number of granted patents for small firms (minor patentees), as plaintiffs, is 4.3 per year while the patents produced by large firms (major patentees) are 94.4 patents per year. Major patentees produce more than twenty times more patents than minor patentees. The average aggregate number of forward citations for minor patentees is 29.1 citations per year-patent portfolio, while the average aggregate number of forward citations for major patentees is 431.3 citations per year-patent portfolio. The average aggregate numbers of backward citations for minor and major patentees are 123.2 and 1116.4 citations, respectively.

The averages of originality measure for minor and major patentees are 2.6 and 45.9, respectively, while the averages of generality measure for minor and major patentees are 1.5 and 21.1, respectively. These sample statistics all provide strong evidence that major patentees, on average, have better and higher-quality patent portfolio and therefore are able to build higher-quality cases than minor patentees as plaintiffs.

It's true that larger firms have more patents and are, therefore, more exposed to litigation. Larger firms are more systematically involved (having less variation in litigiousness) in decision-making during the patent litigation process than small firms. Small plaintiffs, however, have a greater variation in litigiousness for two main reasons: (1) financial constraints, and (2) uncertainty about their patent validity. Consequently, there is a greater variation in litigiousness and therefore a greater variation in the distribution of litigation costs for minor patentees than for major patentees.

Table 3.1: Mean Sample Characteristics from 1996 to 2010

Sample Characteristics for large and small plaintiffs			
	All	Small	Large
Plaintiff Characteristics			
Capital expenditures ($MM)	429.6	3.7	583.9
R&D ($MM)	610.6	11.8	827.7
Market value ($MM)	19237.4	392.2	26066.7
Sales ($MM)	7070.9	48.8	9615.7
Plaintiff employment (per thousands)	23.277	0.188	31.644
Current ratio (current asset/current liability)	3.2	5.6	2.3
Defendant Characteristics			
Capital expenditures ($MM)	434.2	104.2	553.8
R&D ($MM)	458.4	144.1	572.3
Market value ($MM)	15684.7	8517.4	18282.1
Sales ($MM)	7427.9	1622.8	9531.6
Plaintiff employment (per thousands)	29.793	5.876	38.461
Current ratio (current asset/current liability)	3.4	5.4	2.7
Patent Characteristics			
Patent portfolio size per year	70.4	4.3	94.4
Aggregate forward citations per year	324.3	29.1	431.3
Aggregate backward citations per year	852.2	123.2	1116.4
Aggregate originality per year	34.4	2.6	45.9
Aggregate generality per year	15.9	1.5	21.1

3.3.3 Methodology

To explore the determinants of patent litigation and various court outcomes, I estimated a series of logit regressions that predict various court outcomes in any year as a function of litigants' characteristics and patent characteristics. The model is the following:

$$Y_{ABt} \equiv P[firm\ A\ sues\ firm\ B\ in\ yeart] = \frac{e^{z+\delta_t}}{1 + e^{z+\delta_t}}$$

$$Z \equiv \alpha X_{At} + \beta X_{Bt} + \gamma \theta_{At} \quad (3.9)$$

Where X_{it} is a vector of firm characteristics for firm *i* at time *t* and δ_t is a time dummy. θ_{At} is a vector which is a proxy for patent portfolio quality. The litigant characteristics and patent characteristics are explained in the next section in greater detail. This equation is estimated for litigant, plaintiffs and defendants, in a base model for each of parties separately and in a full model for both parties simultaneously.

Using multinomial logit model is not appropriate in my analysis because the multinomial logit model assumes that data are case specific, which means each independent variable has a single value (one choice) for each case. Choices in my analysis are, for example, settling a dispute or requesting an order of injunction. These choices are not independent of each other. In practice, a plaintiff may file for injunction while negotiating over a settlement transfer with a defendant. Both can happen simultaneously. Consequently, a series of logit regressions are more appropriate in predicting the likelihood of filing a patent litigation and various court outcomes.

I also experimented with non-reported probit regressions and the Heckman selection model. The results were quantitatively similar to those from the logit regressions.

3.3.4 Variables

Similar to Hall and Ziedonis (2007) and Bessen and Meurer (2005), I estimate the likelihood of lawsuits at the firm level. This allows me to explore the relationship between litigant characteristics and court outcomes at different stages of the litigation process. The unit of analysis in my research is "firm-year." The main variables of interest are as follows:

Filing a lawsuit. This is a dummy variable if a firm filed a lawsuit. This dependent variable differentiates all identified litigants versus non-litigant firms. For each litigant, a non-litigated firm was chosen randomly with the same 3 digits SIC code and the same filing year. The comparisons between litigated firms and non-litigant firms help to control both for technology and cohort effects.

Settled or probably settled. I create two dummies: (1) if a case settled, and (2) if a case settled or probably settled after filing a lawsuit. In my analysis, consent judgments, stipulated dismissals, and voluntary dismissals were all considered as probable settlements. These dummies are considered as dependent variables in my models.

Other court outcomes. These are dummies if an outcome of a lawsuit is by order of an injunction, pursuing to trial, a win for litigant, or damage payments awarded to plaintiffs. These dummies are considered a dependent variable in my models.

Size of the firm. I use different proxies depending on the analysis such as a log of the number of employees in thousands, a log of total assets in millions, or a log of total sales in millions to measure the effect of size, as an exogenous variable, on filing lawsuits or on other court outcomes. I also estimate separate models based on a plaintiff scale. I divided firms in two groups based on employment size: large firms with 500 or more employees versus small firms with fewer than 500 employees. Table 3.1 indicates the mean statistics for small and large firms.

Capital intensity of the firm. This is the Log of the ratio of capital expenditure (net plant and equipment) to the number of employees. Capital-intensive firms require greater amounts of money and other financial resources to produce goods or services. I expect a negative relationship between capital-intense firms and filing a lawsuit, in contrast to knowledge-intensive firms. Litigation costs, a lack of direct R&D investment, fear of hold up, and having few patents could explain this inverse relationship.

R&D intensity of the firm. This is a log of the ratio of current R&D spending to the number of employees. This is a proxy for knowledge-intensive firms which are more intensively engaged in innovation investment.

Patent yield of R&D. This variable is calculated as a log of patent portfolio (the sum of all granted patents annually) divided by *R&D spending.* This measure captures the success of a firm's R&D program and its long-term strategy to expand its patents.

Current ratio. The current ratio is calculated as current assets divided by current liabilities. This ratio indicates the amount of liquid assets available to liquidate current debt. I expect a positive relationship between the current ratio and filing a lawsuit by plaintiffs. The higher the ratio, the greater the firm's liquidity, which means a firm can better bear litigation costs and pursue at trial. For defendants, a similar relationship makes sense from two standpoints: (1) defendants are financially able to defend and file for a counter suit to prove the invalidity of a patent, and (2) defendants with high cash flow and low liabilities are "juicy targets" for plaintiffs and some plaintiffs can prey on them.

Forward Citations & Backward Citations. This is a log of the ratio of citations (either forward citations or backward citations) to patent portfolio (all patents granted by USPTO) in a given year. I estimate Forward Citations and Backward Citations to be at the aggregate level (the sum of all citations for all granted patents in a given year) divided by patent portfolio per year for a firm in our sample (litigated firms or non-litigated firms). Forward citations are basically future citations received by a patent. Forward citations are one indication that an invention has contributed to the development of subsequent inventions. Thus, forward citations are a measure of a novel invention. Backward citations refer to the number of prior patents cited per claim in patent documents. Evidence of backward citations as a measure of patent quality is ambiguous. Lanjouw and Schankerman (2004) find that backward citations per claim are negatively correlated with litigation probability. Lerner (2006), however, found that

backward citations are positively correlated with litigation in financial patents. Harhoff and Reitzig (2004) have found evidence of a positive association between backward citations and patent litigation. All of these studies found that backward citations, as a proxy of patent quality, are positively correlated with the litigation rate.

Generality and Originality. I estimate originality and generality measures at the aggregate level. The unit of measurement is based on the firm's patent portfolio in a given year. As suggested in Trajtenberg, Jaffe and Henderson, 1997, generality is estimated as:

$$Generality_i = 1 - \sum_j^{n_i} S_{ij}^2 \tag{3.10}$$

"where S_{ij} denotes the percentage of citations received by patent *i* that belong to patent class *j*, out of n_i patent classes (note that the sum is the Herfindahl concentration index)." Trajtenberg, Jaffe and Henderson (1997) explain that "if a patent is cited by subsequent patents that belong to a wide range of fields, the measure will be high, whereas if most citations are concentrated in a few fields, it will be low (close to zero)." They mention that "thinking of forward citations as indicative of the impact of a patent, a high generality score suggests that the patent presumably had a widespread impact, in that it influenced subsequent innovations in a variety of fields." Originality is defined the same way, except that it refers to citations made by patents (backward citations). The originality score will be low if a patent cites previous patents that belong to a narrow set of technologies. Originality and Generality measures tend to be positively correlated with backward citations and forward citations, respectively.

Highly cited patents have higher generality scores, and patents that make lots of citations have a higher originality scores. I expect the valuable patents to be litigated more, and therefore there is a positive relationship between the generality and litigation rate. Conversely, there is a negative relationship between the originality and litigation rates. As a result, valuable patents have a high score of generality and a low score of originality.

Industry group. I divide firms into twelve industry groups according to their primary product categories identified by Compustat database: SIC 28 (chemicals excluding drugs), SIC 283 (drugs, including pharmaceuticals), SIC 35 (machinery, excluding computers), SIC 357 (computer and office equipment), SIC 36 (electronics), SIC 38 (instruments), other manufacturing (SIC 20-39, excluding the above), SIC 50-59 (retail and wholesale), SIC 60-67 (finance, insurance, and real estate), SIC:73 (business services excluding SIC 737), SIC 737 (computer programming, data processing, and other computer-related services), and other non-manufacturing excluding the above.

Other financial variables and dummies. I consider several proxies for a litigant's financial position: profit margin (total net income/loss divided by total sale), return on equity (total net income/loss divided by market value of equity), market value of equity per employee, and leverage (sum of long-term debt and short-term debt divided by sum of long-term debt, short-term debt and total stockholder's equity). I

also define dummies for time (from 1996 to 2010), zero R&D firms, and zero Patent-firms in my models.

In summary, I present a framework for testing two types of models to explain the litigious behavior of litigants during the patent litigation process. First of all, I present a decision model that identifies the main determinants of patent litigation and various court outcomes for both patentees and alleged infringers. I conduct my empirical analysis separately for each litigant, and combine both plaintiffs' characteristics together with defendants' characteristics in a single model. The results of these models provide an estimate of the contribution of each factor, as a determinant, during the litigation process. Secondly, I present a selection model to investigate how the selection process affects litigants' characteristics in suits filed, in relation to the distribution of patentees. The central theme in my analysis is that the cases selected for suit systematically are based on the plaintiff's taste for litigiousness in legal disputes. Plaintiffs are drawn from those corporations with the highest taste for litigation (lowest cost of litigation), conditioned on the positive expected value of a lawsuit.

In the next chapter, I investigate the trends in patent litigation outcomes and implement an empirical analysis of patent litigation outcomes from 1996 to 2010.

Chapter 4

AN EMPIRICAL ANALYSIS OF PATENT LITIGATION OUTCOMES

4.1 Outcomes of Patent Litigation

In this section, I investigate the trends in patent litigation outcomes from 1996 to 2010. Approximately 70% of all settlements occur after a suit is filed. Lanjouw and Schankerman (2001b) indicate that the post-suit settlement rate is high (about 95%). They also state that the larger firms in the new technology area are more likely to settle in the early stages of litigation. Lanjouw and Schankerman (2004) state two main mechanisms—trading intellectual property and expectation of repeated interaction among patentees—that promote settlement of disputes between parties. Repeated interaction in game theory increases incentives to settle disputes cooperatively.

Kesan and Ball (2006) raise concerns regarding the resolution of suits: "Are suits being adjudicated through to a final decision by the courts, or do parties settle their disputes without waiting for a final ruling by the courts?" They discuss that "if the vast majority of cases are settled along the way, the courts may be fulfilling their role of protecting patent rights at relatively low cost." Do courts encourage parties to settle their dispute quickly and effectively?

Some authors (e.g. Hall et al., 2003 and Lanjouw & Schankerman, 2004) mention that 5% of suits are terminated through a trial, and therefore 95% of suits are settled. However, Kesan and Ball (2006) assert that "this figure ignores the fact that many cases are resolved through other pre-trial terminations." My results show that 10.4% of suits are terminated through granting a motion for summary judgment. The actual categories for case disposition reported in the Federal Judicial Center database are shown in Appendix A.

As shown in Table A.1, in Appendix A.1, many of these categories such as "dismissed: other;" and "judgment: other" are quite unclear. The ambiguity of these definitions makes it a difficult task to classify precisely the manner in which suits are decided. Kesan and Ball (2006) give an example that " if the two parties reach an agreement and request that a consent judgment be entered, the final outcomes could be coded as a s*ettlement*, a *consent judgment*, or *judgment: other*." Kesan and Ball (2006) further assert that "there is also some ambiguity about the coding of summary judgment rulings—they can also be classified in the "other judgment" category, as could a consent judgment, which is more likely to be a settlement." In my analysis, consent judgments that are not explicitly named as a settlement, stipulated dismissals, or consent judgments are all considered probable settlements. Voluntary dismissals are also classified as probable settlements. The classification categories are listed in Appendix A.1.

The results of the classification for suits from 1996 to 2010 are shown in Table 4.1. To avoid duplication, I eliminate suits that were transferred to other districts, suits that were remanded, or those reported as a "statistical closing" during the litigation process. About 3.6% of dismissed suits are due to a lack of jurisdiction or want of prosecution. About 10.4% of the suits are terminated in grants of summary judgment which are coded as a motion before trial. About 3.3% of suits are terminated in final trials which include suits disposed of by jury trial, bench trial, or directed verdict. About 6.3% are consent judgments and 1.4% are judgments by default or judgments by arbitrator or by some other final judgment methods. As a consequence, about 21.4% of all suits are terminated by a court decision and through some sort of court ruling (such as grants of summary judgment, trial, consent judgment, etc) on the merits.

Previous studies (e.g. Hall et al., 2003 and Lanjouw & Schankerman, 2004) state that the settlement rate is about 95% of suits. These settled suits all were terminated before trial court. Similar to the Kesan and Ball (2006), I conclude that a much greater share of suits is adjudicated to a final resolution compared to the suggested literature. Our results show that almost three-quarters of federal civil suits are dismissed or settled, about half of the suits that reach the final judgment stage are disposed of via summary judgment and only 15% of suits are terminated in final trials, including suits disposed of by jury trial, bench trial, and directed verdict.

Table 4.1: Patent Litigation Outcomes*

Non-Merit Disposition			Settlement and Probable Settlement			Ruling and Verdict		
Outcome	Number of Cases		Outcome	Number of Cases		Outcome	Number of Cases	
Lack of Jurisdiction	384	1%	Identified Settlements	15921	39%	Summary Judgments**	4222	10.40%
Want of Prosecution	592	1.50%	Consent Judgments	2569	6.30%	Judgment on Jury Verdicts	909	2.20%
Default Judgment	461	1.10%	Voluntary Dismissals	9953	24.50%	Judgment on Bench Trials	428	1%
						Judgment as a Matter of Law (Directed Verdict)	30	0.10%
						Arbitration	11	0%
Subtotals	1053	3.60%		28443	69.90%		5600	13.70%
Total of Dismissals							31,924	
Total of Judgments							8,754	
Total							40,678	

* Patent litigation outcomes were produced by the Federal Judicial Center which keeps statistics on the number of civil cases commenced in federal courts annually and the nature of the suit.

** Includes a motion before trial, and other judgment excluding judgment on jury verdicts, judgment on bench trials, and judgment as a matter of law.

Table 4.2 shows the number of suits disposed of from 1996 to 2010. Nearly half of all dismissed suits are definitely settlements. Kesan and Ball (2006) assert that "cases that terminate in a consent judgment have a high probability of being settled, because in many such cases the parties request a consent agreement/judgment to formalize the settlement." Similarly, a voluntary dismissal is most likely an indicator of settlement. If these suits are included, approximately 70 % of all patent suits are terminated in a settlement, of which 39% are direct settlements, 24.5% are

voluntary dismissals and 6.3% are consent judgments. Voluntary dismissals and consent judgments both suggest probable settlements.

Table 4.2: Patent Litigation Suits Concluded In U.S. District Courts, By Disposition* from 1996 to 2010

Percent of cases disposed											
		Dismissed (%)						Judgment (%)			
Year	Number of complaints disposed**	Settled	Voluntary	Lack of Jurisdiction	Want of prosecution	Other	Total	Consent	Trial***	Other****	Total
1996	1,580	38%	20%	1%	2%	13%	73%	10%	5%	12%	27%
1997	1,667	39%	21%	1%	2%	13%	75%	10%	4%	11%	25%
1998	1,875	38%	20%	1%	2%	13%	74%	10%	5%	12%	26%
1999	2,005	41%	21%	1%	2%	11%	76%	8%	4%	12%	24%
2000	2,040	39%	23%	1%	2%	12%	77%	8%	3%	13%	23%
2001	2,292	40%	22%	1%	2%	11%	77%	8%	3%	12%	23%
2002	2,283	40%	23%	1%	2%	12%	78%	8%	3%	11%	22%
2003	2,368	41%	24%	1%	2%	14%	81%	5%	2%	11%	19%
2004	4,918	38%	25%	1%	2%	14%	80%	6%	3%	11%	20%
2005	2,435	40%	24%	1%	2%	13%	80%	6%	3%	12%	20%
2006	2,502	42%	24%	1%	1%	12%	81%	5%	3%	11%	19%
2007	2,362	39%	25%	1%	1%	11%	77%	6%	3%	14%	23%
2008	4,980	41%	26%	1%	1%	12%	80%	5%	3%	11%	20%
2009	2,449	40%	27%	1%	1%	11%	80%	5%	3%	12%	20%
2010	4,922	36%	29%	1%	1%	14%	80%	4%	4%	12%	20%
Total/Avg%	40,678	39%	24%	1%	1%	12%	78%	6%	3%	12%	22%

* Patent litigation outcomes and disposition codes were produced by the Federal Judicial Center which keeps statistics on the number of civil cases commenced in federal courts annually and the nature of the suit.

**Excludes transfers, remand, and statistical closures.

***Trials includes cases disposed of by jury trial, bench trial, and directed verdict, the parties may have settled before the compeletion of the trial.

****Includes judgments by default, consent, a motion before trial, judgment of arbitrator or by some other final judgment methods.

Table 4.3 describes the number of suits that received monetary awards and also indicate the average of damage awards for each year from 1996 to 2010. Given the insignificant number of rulings of infringement, damages are only awarded in 2.7% of suits (1,096 suits out of 40,678 suits). The average damage award in these suits is $287,000. This figure is biased since the Federal Judicial Center data set recorded any damage awards greater than $1 million as $999,900. The number of suits that received more than $1 million is 230 suits out of 1096 suits. In my opinion, the statistics on average damage award amounts are misleading.

Table 4.3: Damage Awarded to Plaintiff in U.S. District Courts from 1996 to 2010

Number of Cases monetary damages awarded*																
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Trial**	10	21	19	15	17	18	22	9	26	11	6	12	18	10	18	232
Consent Judgment	19	27	31	37	23	27	33	23	76	27	17	24	36	19	38	457
Other Rulings	15	17	18	16	20	28	33	18	48	34	22	23	52	25	38	407
Total	44	65	68	68	60	73	88	50	150	72	45	59	106	54	94	1096
Average Award (in thousands $)	194	243	255	252	183	163	257	361	304	326	362	311	269	478	341	287
* Information on damage awards were produced by the Federal Judicial Center which keeps statistics on the number of civil cases **Trials includes cases disposed of by jury trial, bench trial, and directed verdict.																

Table 4.4 indicates that 435 injunctions out of 726 injunctions are terminated in consent judgments and this indicate injunctions can be found in consent judgment, and similarly a motion before trial is a mechanism to formalize the agreement.

Table 4.4: Injunctions

Number of injunctions*																
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Motion before trial(Summary judgment)	7	3	3	7	7	4	2	12	8	2	3	7	18	4	12	99
Jury Verdict	2	1	6	1	0	1	2	1	8	5	5	2	14	9	10	67
Consent Judgment	28	32	23	23	20	28	41	18	44	25	23	24	46	16	44	435
Default Judgment	0	4	2	2	2	2	3	3	4	6	2	3	4	2	10	49
Other	0	2	2	2	0	8	1	6	12	2	6	12	8	5	10	76
Total	37	42	36	35	29	43	49	40	76	40	39	48	90	36	86	726
As a % of All Cases	2.3	2.5	1.9	1.7	1.4	1.9	2.1	1.7	1.5	1.6	1.6	2	1.8	1.5	1.7	1.80%
* Information on number of injunctions were produced by the Federal Judicial Center which keeps statistics on the number of civil cases commenced in federal courts annually, disposition code, and the nature of the suit.																

Patent litigation literature suggests that settlements increase joint profit for litigants by avoiding the high litigation costs. My results show that nearly 70% of all patent suits settle and only 3% of all suits go to trial due to high litigation costs. The incentive to settle a dispute correlated with the costs of continuing litigation at trial. If litigants are looking for invalidity or infringement outcomes then they have to pay for the benefit of settlement and expenses at trial.

4.2 Litigation Costs Measurement

In this section, I measure the litigation costs associated with the case resolutions. There are different ways we can indirectly measure the litigation costs. Similar to the Kesan and Ball (2006), I use two proxies for costs: "length of time to termination, and whether the suits reached the stage of filing a motion for summary judgment of suits." Time to termination is likely to be inaccurate measure. Kesan and

Ball (2006) assert that "there can be long delays in scheduling court hearings and periods of inactivity that are not necessarily associated with higher costs." In addition, they mention that "costs begin to escalate when cases reach the claim construction or summary judgment stage. Even if the case settles after that point, there will have been a considerable expenditure of resources." All these costs suggest that reaching to stage of filing summary judgment is requiring considerable amount of resources.

Table 4.5 reports our results for the duration of suits filed from 1996 to 2010. The average number of suits was terminated in less than a quarter is 337 cases and the average number of suits which were terminated in eight quarters is 83 cases. The average number of suits lasting more than two years is 422 suits out of 2,372 suits from 1996 to 2010. About 50% of suits are resolved within nine months from 1996 to 2010. The average number of days for the termination of a case is 425 from 1996 to 2010. Similar to Kesan and Ball's results, my results show that expenditures in patent suits, on average, are not extremely high.

Table 4.5: Time to Resolution: All Suits from 1996 to 2010

Number of Days to Resolution*																
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average over years
1 Quarter	230	241	270	308	282	326	250	150	617	316	360	416	558	414	584	337
2 Quarters	299	383	388	402	460	421	340	228	853	468	484	574	871	673	801	482
3 Quarters	225	273	270	285	285	332	251	162	694	357	341	404	606	401	460	337
4 Quarters	171	202	205	180	215	257	187	116	470	264	262	316	435	292	348	247
5 Quarters	152	137	167	167	170	191	147	124	379	204	177	251	391	214	288	200
6 Quarters	102	105	99	144	128	144	112	86	268	169	165	205	258	189	212	151
7 Quarters	85	75	96	79	87	125	91	62	186	155	118	150	204	148	128	113
8 Quarters	45	47	69	64	102	93	68	49	116	73	89	100	180	101	130	83
> 8 Quarters	261	279	316	346	347	366	283	178	725	388	437	558	822	590	787	422
Total	1570	1742	1880	1975	2076	2255	1729	1155	4308	2394	2433	2974	4325	3022	3738	2372
Average number of Days	419	416	419	417	430	415	411	419	417	413	423	445	447	441	450	425

* Information on number of injunctions were produced by the Federal Judicial Center which keeps statistics on the number of civil cases commenced in federal courts annually, disposition code, and the nature of the suit.

I also determine which suits have reached to the stage of motion for summary judgment. I find that 4,222 suits (about 10.4% of all suits) are filed for summary judgment. This statistics indicate that parties bear significant litigation costs for constructing their claims and filing of motion for summary judgment.

Tables 4.6 & 4.7 explain the expenditure levels, measured by number of days to case termination, based on its outcomes. As expected, suits proceed to a final court ruling and trial bear more expenditures than settled suits. The average number of days for termination in suits with a final court ruling is 582 from 1996 to 2010. However, the average number of days for termination for settlement suits or probable settlement suits is 379 from 1996 to 2010. Thus, the number of days to termination is 50-60% higher in suits terminating in rulings than in those that settled or probably settled from

1996 to 2010. In 2010, the average number of suits terminating in a ruling is 686 cases and the average number of suits settled or probably settled is 371 cases.

Table 4.6: Distribution of Number of Days to Termination by Type of Outcomes

Number of Days to Resolution*																
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average over years
Rulings	556	521	542	595	581	506	508	620	579	542	600	650	605	634	686	582
Trial**	875	926	966	1171	1065	847	870	822	967	1090	1023	1150	986	1057	1045	991
Settled	426	455	432	427	454	448	469	451	448	450	448	489	476	503	470	457
Settled or Probably Settled	374	392	374	365	380	380	377	378	368	370	374	394	388	405	371	379

* Information on filing date and termination date were produced by the Federal Judicial Center which keeps statistics on the number of civil cases commenced in federal courts annually and the nature of the suit.

**Trials includes cases disposed of by jury trial, bench trial, and directed verdict, the parties may have settled before the compeletion of the trial.

*** Probable settlement includes cases disposed of voluntary dismissals or consent judgment.

Table 4.7: Distribution of Number of Days to Termination by Summary Judgment and Trial

Number of Days for summary judgment and trial rulings*																
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average over years
Summary Judgment	522	527	505	580	659	468	530	688	639	511	614	637	581	608	703	585
Trial**	875	926	966	1171	1065	847	870	822	967	1090	1023	1150	986	1057	1045	991

* Information on filing date and termination date were produced by the Federal Judicial Center which keeps statistics on the number of civil cases commenced in federal courts annually, the nature of judgment, and the nature of the suit.

**Trials includes cases disposed of by jury trial, bench trial, and directed verdict, the parties may have settled before the compeletion of the trial.

Another way to measure the level of expenditures on suits is to determine at which stage a suit terminated. Whether parties are involved in the *filing of motions for summary judgment* or *continued to trial court* indicate that they have invested considerable amount of resources during the litigation process. As is shown in Table 4.7, my results support the fact that the most expensive suits are those that go to trial. The average number of days for termination in trial suits is 991 which is almost twice as much as the settlement termination. In 2010, the average number of days for trial suits is 1,045 days. These figures for trial suits indicate litigants must bear high costs of litigation compared to settled suits. In addition, my results indicate the suits that terminated through summary judgment motions also require a significant level of expenditures. The average number of suits terminated through summary judgment is 585 days. In 2010, this figure increased to 703 days.

These results suggest that there are slight fluctuations in some years from 1996 to 2010 in the level of expenditures across the two types of rulings—trial and summary judgment. On average, the duration of summary judgment suits grow by about 3.4% annually, and the duration of trial suits grow by about 2% yearly. The average number of days for termination for summary judgment is 585 while the average number of days that suits went to trial is 991 from 1996 to 2010.

In conclusion, my results indicate that cost of filing for a motion of summary judgments is growing at a relatively faster rate than pursuing at trial. However, suits that go to trial are much more costly than those suits resolved through summary

judgment rulings from 1996 to 2010. Similar to Kesan and Ball (2006), my results show that many more patent suits are continuing at trial or filing for summary judgment than commonly expected. However, about three-quarters of patent litigation suits are settled or probably settled. My results indicate that patent litigation is mainly a settlement mechanism.

4.3 Patent Litigation Outcomes across Industry Groups

I investigate patent litigation outcomes within the industry groups in Table 4.8. I divide litigants into twelve industry groups according to their primary product category as identified by Compustat: SIC 28 (chemicals excluding drugs), SIC 283 (drugs, including pharmaceuticals), SIC 35 (machinery, excluding computers), SIC 357(computer and office equipment), SIC 36 (electronics), SIC 38 (instruments), other manufacturing (SIC 20-39, excluding the above), SIC 50-59 (retail and wholesale), SIC 60-67 (finance, insurance, and real estate), SIC:73 (business services excluding SIC 737),SIC 737 (computer programming, data processing, and other computer-related services), and other non-manufacturing, excluding the above.

Table 4.8: Patent Litigation Outcomes by Industry Groups

Patent Litigation Outcomes by the Industry Groups								
	Settled		Settled & probably settled**		Injunctions		Trials	
SIC Classifications	Number of cases	% of identified sample	Number of cases	% of identified sample	Number of cases	% of identified sample	Number of cases	% of identified sample
Chemicals (SIC:28)	180 4.50%	1.60%	288 4.10%	2.50%	2 1.40%	0.00%	13 8.60%	0.10%
Pharmaceuticals/ Drugs (SIC:283)	460 11.50%	4.00%	920 13.10%	7.90%	34 24.10%	0.30%	58 38.20%	0.50%
Machinery (SIC:35)	200 5.00%	1.70%	347 4.90%	3.00%	7 5.00%	0.10%	7 4.60%	0.10%
Computers (SIC:357)	284 7.10%	2.50%	478 6.80%	4.10%	1 0.70%	0.00%	4 2.60%	0.00%
Electronics (SIC:36)	649 16.20%	5.60%	1082 15.40%	9.30%	12 8.50%	0.10%	9 5.90%	0.10%
Instruments (SIC:38)	542 13.50%	4.70%	954 13.50%	8.20%	28 19.90%	0.20%	14 9.20%	0.10%
Manufacturing (SIC 20-39)	623 15.50%	5.40%	1076 15.30%	9.30%	26 18.40%	0.20%	16 10.50%	0.10%
Retail and wholesale (SIC: 50-59)	271 6.80%	2.30%	483 6.90%	4.20%	5 3.50%	0.00%	7 4.60%	0.10%
Finance, insurance and real estate(SIC:60-67)	91 2.30%	0.80%	177 2.50%	1.50%	3 2.10%	0.00%	0 0.00%	0.00%
Business services(SIC:73)	24 0.60%	0.20%	61 0.90%	0.50%	2 1.40%	0.00%	1 0.70%	0.00%
Computer programming/ Software (SIC: 737)	365 9.10%	3.20%	592 8.40%	5.10%	8 5.70%	0.10%	10 6.60%	0.10%
Other non-manufacturing	325 8.10%	2.80%	585 8.30%	5.10%	13 9.20%	0.10%	13 8.60%	0.10%
Total number of cases	4014 100%	34.70%	7043 100%	60.80%	141 100%	1.20%	152 100%	1.30%
Total identified sample	11583	100%		100%		100%		100%

The statistics in Table 4.8 indicate that about 60% of our sample consists of 11,583 lawsuit cases which are settled or probably settled, which is similar to my earlier finding in Table 4.1. The highest numbers of settled and probably settled suits in our sample are associated with electronics, manufacturing, and instruments

industries. About 1.2% of our sample (141 out of 11,583) is granted preliminary injunctions.

My results indicate that both the granting of a preliminary injunction and going to trial are more popular among the pharmaceuticals/drugs, instruments, and manufacturing industries. In the pharmaceuticals/drugs industries, about 1 out of four suits are granted a preliminary injunction and two out of five suits are adjudicated at trial court. Moreover, about 9% of plaintiffs in chemicals industry continue their disputes at trial court. This arises from a higher uncertainty in these industries and the greater amount of necessary R&D spending. The nature of this uncertainty is from the fact that pharmaceutical patents are easily and cheaply replicated with little investment. Consequently, pharmaceutical firms are not willing to resolve a dispute in a cooperative solution via a settlement in the early stages of the litigation process. I believe that firms in chemicals, drugs, and pharmaceuticals industries are relatively less likely to settle than other industries. As statistics suggest, 40% of filed suits in the pharmaceuticals/drugs industries are granted a preliminary injunction and 25% of them filed suits to continue their disputes at trial court.

Evidence provided by Bessen and Meurer (2005) shows that the likelihood of patent infringement is particularly high in the electronics (SIC 36) and instruments (SIC 38) industries that both are classified as complex product industries. I bring evidence that almost 20% of instrument suits are granted a preliminary injunction and almost 10% of them continued at trial court. Similarly, 8.5% of filed suits in the

electronics industry are granted a preliminary injunction, and about 6% of them go to trial court. Similar to the pharmaceutical industry, these results arise from a higher uncertainty (complex nature of patented products) in these industries and the greater amount of necessary R&D spending, which lead to a relatively higher trial rate and injunction rate in electronic and instrument industries than other industries.

4.4 Patent Litigation Outcomes by Plaintiffs Scale

Table 4.9 presents a frequency table of lawsuits and various court outcomes in small and large corporations. My results show that 3.4 % of minor patentees which filed a lawsuit decide to go to trial, while 63% of them settle a dispute prior to trial. About 2.8 % of minor patentees are granted a preliminary injunction. About 8.9% of minor patentees can defeat defendants, and only 3.2% of them are entitled to damage awards.

The trial rate of 4.7% among major patentees is major than minor patentees, which is not consistent with hypothesis 1. About 62% of major patentees settle their dispute prior to trial, which is almost the same rate for minor patentees. The injunction rate is about 1.8% for major patentees, which is 1% lower than the rate for minor patentees. About 9.2% of major patentees prevail in a lawsuit, and only 2.9% of them are entitled to damage awards.

Table 4.10 shows the average number of employees in small and large firms as patentees. These large differences in the number of employees emphasize that multiple

factors influence filing a lawsuit and various court outcomes for major versus minor patentees which lead to a greater variation in the distribution of costs among minor patentees than major patentees.

In summary, this chapter investigates the trend in patent litigation outcomes from 1996 to 2010. My results indicate that many more patent suits are continuing at trial or filing for summary judgment motion than commonly is expected. However, about three-quarters of patent litigation suits are settled or probably settled. My results demonstrate that expenditures in patent suits, on average, are not extremely high, and patent litigation is largely a settlement mechanism.

A simple set of statistics cannot differentiate variations in the distribution of costs among minor and major patentees. Instead, a multiple regression approach is required to understand the factors affecting the selection process for lawsuits, and consequently various court outcomes among minor and major patentees.

In the next chapter, I present my empirical results using regression models. I identify the main determinants of filing a patent lawsuit and various court outcomes. I also investigate how the selection process affects litigants' characteristics in suits filed in relation to the distribution of the patent.

Table 4.9: Frequency of Lawsuits and Various court outcomes in Small and Large Firms

Frequency of lawsuits and different court outcomes in small and large corporations											
	Lawsuit	Trial		Settlement		Injunction		Plaintiff Win		Money Awarded	
Scale	Frequency	Frequency	Rate per 1000 lawsuit case	Frequency	Rate per 1000 lawsuit case	Frequency	Rate per 1000 lawsuit case	Frequency	Rate per 1000 lawsuit case	Frequency	Rate per 1000 lawsuit case
Small Firms (Emp_plt < 500)	617	21	34	389	630	17	28	55	89	20	32
Large Firms (Emp_plt >= 500)	3077	144	47	1910	621	55	18	283	92	88	29
All Firms	3694	165	45	2299	622	72	19	338	91	108	29

Table 4.10: Average Number of Employees in Small and Large Firms Based on Type of Outcomes

Average number of employees in small and large corporations based on the different court outcomes							
		Lawsuit	Trial	Settlement	Injunction	Plaintiff Win	Money Awarded
Small Firms	If Emp_plt < 500	158	138	168	79	141	131
Large Firms	If Emp_plt >= 500	39527	45587	37958	28493	28840	21824

Chapter 5

EMPIRICAL RESULTS: DECISION MODELS AND SELECTION MODELS

5.1 Decision Models: Analysis of Determinants

In this section, I identify determinants of filing a patent lawsuit, settling a dispute, granting an injunction, proceeding to trial, and winning or losing at trial. Lerner (2010) states that factors that affect the decision to settle a dispute prior to trial should drive the decision to settle prior to filing a lawsuit. The same factors, which are the probability of success, the extent of uncertainty, and the expected rewards at trial if successful, also shape the decision to file a lawsuit and proceed to trial. Bessen and Meurer (2005) assert that "the expected cost of patent disputes varies proportionally with the firm's hazard rate of entering disputes." This expected cost reduces a firm's incentive to invest in R&D.

I present a decision model that identifies the main factors that explain the behavior of litigants during the patent litigation process. I identify the main determinants of filing a patent lawsuit and post-suit court outcomes (e.g. injunction, trial, settlement, win or loss at trial) during the patent litigation for both potential plaintiffs or "patentees" and defendants or "alleged infringers." I conduct an empirical analysis at two levels: (1) separately for each litigant, and (2) combining both

plaintiffs' characteristics together with defendants' characteristics. This analysis gives an estimate of the contribution of each factor to filing a lawsuit and various court outcomes at each stage of the litigation process.

5.1.1 Regression Analysis of Filing a Lawsuit

To analyze litigation determinants, I estimate the logit regressions of the probability that a firm as a plaintiff with given financial and patent characteristics will sue a firm as a defendant with other financial characteristics in a given year. The mean sample characteristics are provided in Appendix B.1. Table 5.1 shows the effect of plaintiffs' financial characteristics and patent characteristics on patent lawsuit rates. The coefficients of the log of sales and the log of market value per employee are clearly significant in all specifications for plaintiffs. The coefficients of firm sales ranged from a low of 0.32 to a high of 0.34 and are highly significant in all variations. The strongest driver of a firm being a plaintiff in patent litigation is its scale.

The coefficients on the log of market value per employee ranged from a low of 0.18 to a high of 0.28 and are highly significant and positive in all variations. My results suggest that financial productivity matters for plaintiffs because it is associated with greater stakes in litigation. Regarding the R&D expenditures per employee, all coefficients are positive and significant in regressions 4 to 6. The greater R&D a firm invests lead to a greater risk of patent infringement.

The log of capital expenditures per employee is negative in all variations, but not significantly different from zero. Bessen and Meurer (2005) argue that capital intensive-litigants may be vulnerable to patent injunction, and therefore settle more frequently to avoid litigation costs. Also, Hall and Ziedonis (2010) provide evidence of a negative relationship between capital intensive firms and filing a lawsuit in the semiconductor industry. They argue that the fear of holdup is the main reason for this pattern. My findings confirm their conclusions. My results suggest that capital-intensive plaintiffs settle before and after filing a lawsuit more frequently because of: (1) avoiding a holdup in counter lawsuits, and (2) avoiding associated litigation costs.

Current ratio (current assets divided by current liability), is negative in regression 5, as expected, and highly significant. One likely explanation is that plaintiffs with a low level of liquidity are targeting financially strong defendants (defendants with high cash flows and low liabilities) to earn a higher settlement transfer during the litigation process or damage awards at trial.

The log of patent portfolio per $1million R&D spending is positive, as expected, in all variations, and significantly different from zero. The log of forward citations divided by patent portfolio is positive and significant in regressions 1, 3, 4, & 5. The log of backward citations divided by patent portfolio is positive and highly significant.

Originality measures turn out in positive signs in all specifications, and conversely, generality measures are in negative signs in all variations except regression

5. Both measures are not significantly different from zero. Valuable patents are litigated more than other patents, and therefore a positive relationship between patent quality and litigation rate exists. Valuable patents have a high score of generality and a low score of originality. My results provide weak evidence for this argument. One likely explanation is that patents with a large number of backward citations and a high score of originality have "fuzzy boundaries" with other patents in the same or different technological spaces and therefore are litigated more that other patents. If the above explanation is correct, then my results about the positive relationship of originality and backward citations with filing a lawsuit make more sense

Table 5.1: Logit Regression for Probability of Being Involved in a Patent Litigation Lawsuit as a Plaintiff

Logit regressions for probability of being involved in litigation-Plaintiffs										
Dependent Variable: Filing lawsuit as a patentee litigant	1		2		3		4		5	
Plaintiff Characteristics										
Ln Capital Exp/employee					-0.06	(0.06)	-0.08	(0.06)	-0.07	(0.06)
Ln R&D/employee	0.02	(0.02)	0.08	(0.05)	0.06***	(0.02)	0.13***	(0.05)	0.13**	(0.05)
Ln Mkt Value/employee	0.23***	(0.04)	0.18***	(0.05)	0.25***	(0.05)	0.20***	(0.05)	0.28***	(0.06)
Ln Sales	0.32***	(0.02)	0.34***	(0.03)	0.36***	(0.03)	0.38***	(0.03)	0.33***	(0.03)
Current ratio (current asset/current liability)									-0.09***	(0.02)
Patent Characteristics										
Ln Pat Portfolio/R&D	0.11***	(0.04)	0.05	(0.04)	0.12***	(0.04)	0.08*	(0.04)	0.10**	(0.04)
Ln Forward Cites/ Pat Portfolio	0.08*	(0.05)	0.14***	(0.05)	0.06	(0.05)	0.12**	(0.05)	0.11**	(0.05)
Ln Backward Cites/ Pat Portfolio	0.26***	(0.04)	0.57***	(0.07)	0.27***	(0.04)	0.56***	(0.07)	0.55***	(0.07)
Originality	0.001	(0.001)	0.001	(0.002)	0.000	(0.001)	0.001	(0.001)	0.00	(0.001)
Generality	-0.001	(0.002)	-0.002	(0.002)	-0.001	(0.002)	-0.002	(0.002)	0.00	(0.002)
D (R&D=0)			1.25***	(0.21)			1.14***	(0.21)	1.07***	(0.22)
D (Pat Portfolio=0)			0.51	(0.47)			0.75	(0.48)	0.65	(0.49)
Number of obs	4770		4770		4708		4708		4634	
Log pseudo likelihood	-1736.5		-1718.3		-1695.6		-1679.9		-1641.1	
Pseudo R2	0.38		0.39		0.39		0.39		0.40	

Note: The dependent variable is a dummy if a firm filed a lawsuit. Logit regressions with year dummies and industry dummies are not shown.
Robust standard errors are in parentheses.
*Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level

Table 5.2 reports the probability of filing a lawsuit considering both litigants' characteristics together with patent characteristics. Column one in Table 5.2 repeats regression 6 in Table 5.2 for all firms by adding defendants' financial characteristics to the model. This enables us to understand the identity and purpose of defendants in patent infringement. My results for plaintiffs' characteristics are similar to the results in Table 5.1.

The log of defendant’s capital expenditures per employee is positive and highly significant at the 1% confidence level. Bessen and Meurer (2005) argue that capital intensive-firms may be vulnerable to patent injunction, and therefore settle more frequently to avoid litigation costs. However, some plaintiffs refuse to settle before and after filing a lawsuit because of imposing more risk by requesting a preliminary injunction for capital-intensive defendants and they continue litigation to earn a higher settlement fee or damage awards at trial.

Regarding defendant’s R&D expenditures per employee, the coefficient is positive and significant at a 5% confidence level for both litigants. The greater R&D a firm invests, as a plaintiff, lead to a greater risk of patent infringement. The positive coefficient of the defendant's R&D spending suggests that defendants invest in R&D in spite of their potentially infringing behavior. One likely reason is explained by Bessen and Meurer (2005) is that "defendants in patent lawsuits are not merely copying to avoid spending R&D or only spending as necessary to invent around patents."

A firm's market value matters for firms because it is correlated with greater risks in dispute. Market value per employee indicates the value of "an unobserved firm's technologies". True infringers see patent infringement as an opportunity to promote their technology and to earn a profit. The coefficient on the log of defendant's market value per employee is negative, as expected, and not significantly different from zero. The coefficient of defendant's sales is positive and significant at a 1% confidence level. The coefficient of defendant sales (0.07), is six times smaller than the coefficient of plaintiff's sales (0.45), suggesting that the probability of litigation grows faster with plaintiff's scales than with defendant's scales.

The coefficient of the current ratio is negative for plaintiffs and positive for defendants; both are significant at 1% and 5%, respectively. This pattern may suggest that some plaintiffs target financially secure defendants to earn a higher settlement transfer during the litigation process or damage awards at trial.

The log of patent portfolio per $1million R&D spending is positive, as expected, and significant at 5%. This suggests that the probability of filing a lawsuit increases with patent-intensive firms. The log of forward citations divided by patent portfolio is positive, but not significantly different from zero. The log of backward citations divided by patent portfolio is positive and significant at 1%. Both forward citations and backward citations, as a proxy for patent quality, positively increase the probability of filing a lawsuit. Neither generality nor originality measures are significantly different from zero.

Table 5.2: Logit Regression for Probability of Filing a Lawsuit for Different Classification of Litigants

Logit regressions for probability of being involved in litigation- Plaintiffs & Defendants																
Dependent Variable: Filing lawsuit																
	All		Industry Group				Competition				Plaintiffs Employment Size				Defendants Employment Size			
			Pharmaceuticals		Computers/Software		Rival Firms		Non rival Firms		Plt<500		Plt≥500		Def<500		Def≥500	
Plaintiff Characteristics																		
Ln Capital Exp/employee	-0.43***	(0.12)	-0.42***	(0.14)	-0.25**	(0.11)	-0.07	(0.1)	-0.20***	(0.05)	-0.36*	(0.21)	-0.17***	(0.04)	-0.46	(0.39)	-0.22***	(0.05)
Ln R&D/employee	0.19**	(0.1)	0.22*	(0.13)	0.05	(0.06)	0.08	(0.08)	0.12***	(0.04)	1.55***	(0.4)	0.09***	(0.03)	0.63***	(0.25)	0.10***	(0.03)
Ln Mkt Value/employee	0.26***	(0.09)	-0.09	(0.06)	0.08	(0.07)	0.13**	(0.06)	0.07*	(0.04)	0.08	(0.13)	0.05*	(0.03)	0.33	(0.3)	0.05**	(0.03)
Ln Sales	0.45***	(0.05)	0.65***	(0.11)	0.11	(0.08)	0.41***	(0.06)	0.13***	(0.05)	-2.24***	(0.57)	0.26***	(0.05)	2.82***	(0.67)	-0.03	(0.04)
Current ratio (current asset/current liability)	-0.14***	(0.04)	-0.14**	(0.06)	-0.37***	(0.1)	-0.26***	(0.08)	-0.08*	(0.04)	-0.47***	(0.13)	-0.05	(0.04)	-0.54**	(0.26)	-0.04	(0.04)
Defendant Characteristics																		
Ln Capital Exp/employee	0.26***	(0.1)	0.20**	(0.1)	-0.18	(0.11)	-0.12	(0.08)	0.08	(0.05)	0.24	(0.2)	0.03	(0.03)	0.32	(0.35)	0.18***	(0.06)
Ln R&D/employee	0.18**	(0.08)	-0.36***	(0.09)	-0.07	(0.05)	0.17**	(0.07)	-0.15***	(0.03)	-1.29***	(0.4)	-0.03	(0.02)	-0.55**	(0.23)	-0.04*	(0.02)
Ln Mkt Value/employee	-0.12	(0.08)	0.02	(0.05)	-0.06	(0.05)	-0.06	(0.05)	-0.08***	(0.03)	-0.06	(0.13)	-0.01	(0.02)	-0.34	(0.27)	0.04*	(0.02)
Ln Sales	0.07**	(0.04)	-0.11	(0.08)	0.29***	(0.07)	-0.06	(0.06)	0.17***	(0.04)	2.74***	(0.58)	-0.07**	(0.03)	-2.30***	(0.67)	0.23***	(0.04)
Current ratio (current asset/current liability)	0.05**	(0.03)	0.02	(0.05)	0.36***	(0.09)	0.24***	(0.08)	0.05	(0.03)	0.42***	(0.14)	0.08***	(0.03)	0.44**	(0.22)	0.03	(0.04)
Patent Characteristics																		
Ln Pat Portfolio/R&D	0.12**	(0.05)	0.09	(0.12)	-0.15	(0.1)	-0.06	(0.05)	-0.03	(0.05)	0.19	(0.18)	-0.11***	(0.04)	-0.06	(0.15)	-0.20***	(0.04)
Ln Forward Cites/ Pat Portfolio	0.07	(0.06)	-0.01	(0.18)	-0.04	(0.12)	0.14**	(0.07)	0.03	(0.06)	-0.06	(0.21)	0.06	(0.06)	0.19	(0.19)	0.01	(0.06)
Ln Backward Cites/ Pat Portfolio	0.30***	(0.09)	-0.28*	(0.15)	0.30**	(0.11)	0.24***	(0.06)	0.28***	(0.05)	0.15	(0.12)	0.25***	(0.05)	0.13	(0.15)	0.17***	(0.05)
Originality	-0.001	(0.001)	0.01	(0.01)	-0.001	(0.001)	0.0002	(0.001)	0.002	(0.002)	-0.14**	(0.07)	0.001	(0.001)	0.01	(0.04)	0.002	(0.002)
Generality	-0.0001	(0.002)	-0.01	(0.02)	0.002	(0.002)	-0.002	(0.002)	0.0005	(0.002)	0.15	(0.1)	0.001	(0.002)	0.005	(0.09)	-0.0001	(0.002)
Number of obs	2252		613		500		2092		2109		722		2051		867		1904	
Log pseudo likelihood	-1134.1		-187.0		-259.6		-947.3		-1037.4		-122.8		-1196.8		-157.9		-1122.0	
Pseudo R2	0.27		0.54		0.25		0.28		0.22		0.65		0.13		0.71		0.14	

Note: The dependent variable is a dummy if a firm as a plaintiff filed a lawsuit against defendant. Logit regressions with year dummies are not shown.

Dummies for "No R&D firms" and "No Patent firms" are not shown too. Robust standard errors are in parentheses.

*Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level

Patents work differently in different industries. As literature suggests (e.g, Wegner, 1994) in the pharmaceutical, biotechnology, and chemical industries, the patent considered equal to the final product. The pharmaceutical industries heavily rely on patent protection. Patent in the pharmaceutical industries could easily be replicated with little investment. Most of R&D investment in the pharmaceutical industries goes to the laboratory research and clinical trials rather than manufacturing investment of final products. Hence, patent is only effective way to protect owners' right and to produce returns on R&D investment.

My results indicate that firms in chemicals, drugs, and pharmaceuticals industries are relatively less likely to settle than other industries before or at early stages of the litigation process. This arises from a higher uncertainty in these industries and a greater amount of necessary R&D spending which increases a firms' willingness to file a lawsuit and to request a preliminary injunction soon after filing a lawsuit and even continue their disputes at trial court. Patents in new technologies, such as software and computer programming, are more likely to be involved in dispute than those industries in mature technologies. Uncertainty in these new fields arises from "fuzzy boundaries" of patents in the same technological space.

Regressions in the second and third columns (industry group category) in Table 5.2 repeat the regression in the first column (firms in all industries) for firms in SIC 282 (pharmaceutical industries) and for firms in SIC 357 & 737 (computers, computer programming, and software industries). Capital-intensive defendants in pharmaceutical

firms prefer to continue a lawsuit and seek a non-collaborative solution. One likely explanation is that defendants which are investing huge amounts of R&D in their patents want to prove patent invalidity via a counter lawsuit. However, by considering the negative coefficient of defendant's R&D, which is -0.36 and significant at a 5% confidence level, I could reject the above explanation. The likelihood of filing a lawsuit increases when defendants cut down R&D expenditures. One difference that stands out is that litigants' R&D spending tends to be the strongest determinant of litigation in pharmaceutical industries. The larger R&D coefficients suggest more aggressive patent enforcements are required in the pharmaceutical industries.

The strongest determinant of litigation in the computer and software industries is the litigant's current ratio. The coefficient of the plaintiff's current ratio is -0.37 and the coefficient of defendant's current ratio is 0.36; both are significant at 1%. This pattern is consistent with the view that some plaintiffs target financially secure defendants (with high cash flow and liquidity) to earn a higher settlement transfer at each stage of the litigation process or damage awards at trial. As expected, originality turned out to have a negative coefficient sign while generality is with positive coefficient sign in the computer and software industries, but never significant. The likelihood of filing a lawsuit increases with generality and decreases with originality.

The next comparison in Table 5.2 is between rival and non-rival litigants. I define litigants as *rival firms* if they operate in the same technological space using a 3 digit SIC code. The coefficient of the log of patent portfolio per $1M R&D spending

turns out to be negative and insignificant for rival firms. The coefficient of the log of aggregate forward citations per patent portfolio for rival firms is 0.14 and significant at 5% which is two times greater in magnitude than for all the firms in the first column. Highly cited patents make a firm more likely to sue its rival, and this is solely explained by the technological proximity. The coefficient of the log of aggregate backward citations per patent portfolio is positive and significant at 1%. One likely explanation is that patents with high backward citations have "fuzzy boundaries" with other patents in the same technological space and are therefore litigated more than other patents. Another explanation would be that a larger number of backward citations indicate a novel utility of existing innovation. The main determinants of litigation for non-rival firms are capital intensity, R&D intensity, market value, scale, and the number of backward citations.

The last comparison in table 5.2 is between large and small litigants which investigate the scale effects on litigation. I separated litigants into two categories and estimated regressions for firms with fewer than 500 employees and firms with 500 or more employees. Capital intensity is positive in all regressions and has an influential effect on the litigation rate. Interestingly, the coefficient of the log of R&D per employee for small plaintiffs is 1.55 and significant at 1% which is six times greater than in the regression for all firms reported in the first column. The coefficient of the log of R&D per employee for plaintiffs facing small defendants is 0.63 and is significant at 1% which is three times greater than all firms' regression in the first

column. As expected, the coefficient of the log of R&D per employee for defendants facing small plaintiffs is -1.29 and significant at 1%. This coefficient for small defendants is -0.55 and significant at 5%. R&D intensity tends to be more strongly associated among litigants of a smaller size. The current ratio for both litigants turns out to be of a larger magnitude for smaller litigants.

The coefficient of generality measure is 0.15 but not significantly different from zero. The coefficient of originality is -0.14 and significant at 5%. Small innovative firms have greater exposure of patent infringement simply because of their valuable patents. For litigants of a larger size, the plaintiff's patent portfolio per R&D inversely affects the litigation rate. Larger defendants are less likely to infringe on innovative firms which have a large pool of patents. The main determinants of filing a patent litigation for small firms are R&D intensity, scale, and liquidity level while the influential determinants of litigation for large firms are not only R&D intensity, scale, and liquidity level, but also market value, patent portfolio per R&D, and the number of backward citations.

5.1.2 Regression Analysis of Settlement

To analyze what drives settlements after filing a lawsuit, I estimate the logit regressions of the probability that a firm with a given characteristic will settle a suit with other firms in a given year. I estimate my models using the two main samples. The primary sample includes the financial characteristics of defendants and plaintiffs.

The mean of sample characteristics is provided in Appendix B.2. Tables 5.3-5.5 estimate the main determinants of the settlement using the litigants' characteristics. I then add patent characteristics to litigants' characteristics to estimate my models. Tables 5.6 & 5.7 represent the results for estimated settlement regressions using both litigants' characteristics and patent characteristics.

Table 5.3 indicates the results for probability of a settlement for defendant litigants. I include industry dummies and fifteen year dummies from 1996 to 2010 to all regressions. I employ two measures of size—the log of the firm employment and the log of the firm's total assets. The Log of firms' assets is clearly significant in columns 2, 3, and 4 with an average coefficient of 0.23 for alleged infringers. These coefficients are significantly greater than zero, suggesting that financial scale matters because it is associated with greater stakes in the settlement. Large defendants prefer to settle soon mainly because of litigation costs. Similarly, the coefficient of the defendant's employment size in columns 5 and 6 appear to be positive, at 0.25, and significantly greater than zero. Both measures of size are positively correlated with the settlement rate.

All other non-ratio variables in my analysis are scaled by a firm's employment. The coefficient on the log of R&D spending per employee is positive and is significantly different from zero in columns 5 and 6. These results suggest that the settlement rate increases with development investment by defendants. R&D-intensive defendants firms settle quickly to avoid litigation costs.

The regressions in the second and third columns include the log of market value of equity per employee. The coefficients on both regressions are negative and significantly different from zero. These firms prefer not to settle and pursue a non-cooperative solution. These results suggest that defendants with a high market value more likely intend to prove that the plaintiff's patents are invalid. Consequently, those alleged infringers often initiate a counter-suit. Another likely explanation is that innovative defendants are a "juicy target" for plaintiffs. Some plaintiffs refuse to settle for a greater damage award or higher settlement transfer at trial.

My results relating to the leverage ratio can be found in columns 2, 3, and 6, and they indicate that as defendant' debts increase, settlement negotiations fail. Highly leveraged defendants firms are less likely to be able to afford a settlement transfer. Conversely, having a lower degree of defendant's leverage increases the likelihood of settlement.

Regarding defendant's current ratio, the coefficients appear negative and significant in all specifications, except in column 5. Our interpretation over the current ratio is similar to the log of market value of equity per employee in that highly liquid defendants are targeted by plaintiffs whose settlement payoffs are less than non-settlement payoffs.

My results relating to the return on equity indicate that there is a positive relationship between the defendant's financial performance and settlement rate.

Profitable firms act rationally and therefore seek cooperative solutions through settlement to mitigate their uncertainty.

All regressions in Table 5.3 included dummies for different industry groups. All industry groups seem to exhibit similar pattern in all specifications. Chemical and drug industries, including pharmaceuticals, have the highest negative coefficients in regressions 3, 4, 5, and 6 and they are highly significant compared to other industry groups. My results provide clear evidence that firms operating in chemical, drugs, and pharmaceuticals industries are less likely to settle, compared to other industries. Moreover, the dummy coefficients in computers, software, and computer programming industries turn out to be negative and are highly significant, but less in magnitude than chemical, drugs, and pharmaceuticals industries, in regressions 3, 4, 5 and 6. This suggest that firms operating in computers, software, and computer programming industries are less likely to settle with defendants during the early stages of litigation, mainly for two reasons: (1) the complexity of the case due to "fuzzy boundaries" of patent claims, and (2) the defendant's efforts to prove patent invalidity by initiating a counter-suit or filing for antitrust.

Table 5.3: Regression for Probability of Settlement - Defendants

Logit regressions for probability of settlement-Defendants						
Dependent Variable: Settled & Probability Settled	**1**	**2**	**3**	**4**	**5**	**6**
Ln Mkt Value/employee		-0.03*	-0.07**		0.02	
		(0.02)	(0.03)		(0.03)	
Ln R&D/employee			0.04	0.02	0.08***	0.06***
			(0.02)	(0.02)	(0.02)	(0.02)
Leverage		-0.42***	-0.43**			-0.35**
		(0.15)	(0.21)			(0.18)
Current ratio (current asset/current liability)		-0.01**	-0.02**	-0.02***	-0.01	
		(0.01)	(0.01)	(0.01)	(0.01)	
Return on Equity				0.0001***	0.0001***	0.0001***
				(0)	(0)	(0)
Ln Total Asset		0.24***	0.23***	0.22***		
		(0.01)	(0.01)	(0.01)		
Ln employee					0.25***	0.25***
					(0.01)	(0.01)
Chemicals (SIC:28)	0.02	-0.08	-0.89***	-0.87***	-0.89***	-0.83***
	(0. 13)	(0. 15)	(0.2)	(0.2)	(0.19)	(0.19)
Machinery (SIC:35)	0.1	0.23*	-0.52***	-0.48***	-0.57***	-0.53***
	(0. 12)	(0.13)	(0.18)	(0.18)	(0.18)	(0.18)
Electronics (SIC:36)	0.18**	0.26***	-0.55***	-0.50***	-0.61***	-0.59***
	(0. 09)	(0.1)	(0.16)	(0.16)	(0.16)	(0.15)
Instruments (SIC:38)	0.16*	0.51***	-0.27*	-0.22	-0.33**	-0.33**
	(0. 09)	(0.11)	(0.16)	(0.16)	(0.16)	(0.16)
Business services (SIC:73)	-0.16	-0.02	0.3	0.34	0.33	0.34
	(0. 27)	(0. 31)	(0.52)	(0.53)	(0.51)	(0.51)
Drugs/Pharmaceuticals (SIC:283)	-0.26***	-0.12	-0.94***	-0.90***	-0.97***	-0.94***
	(0. 09)	(0. 11)	(0.17)	(0.17)	(0.16)	(0.16)
Computers (SIC:357)	-0.07	-0.07	-0.89***	-0.82***	-0.92***	-0.90***
	(0. 10)	(0. 12)	(0.17)	(0.17)	(0.17)	(0.16)
Computer programming/Software (SIC: 737)	0.01	0.14	-0.61***	-0.57***	-0.67***	-0.63***
	(0. 09)	(0. 11)	(0.17)	(0.17)	(0.17)	(0.16)
Manufacturing (SIC 20-39)	0.08	0.09	-0.60***	-0.56***	-0.61***	-0.67***
	(0. 09)	(0. 10)	(0.17)	(0.17)	(0.17)	(0.16)
Retail and wholesale (SIC: 50-59)	0.25***	0.26**	-0.21	-0.18	-0.22***	-0.22
	(0.14)	(0. 11)	(0.26)	(0.26)	(0.26)	(0.25)
Finance, insurance and real estate (SIC:60-67)	-0.11	0.73**	0.05	0.01	0.02	0.21
	(0.17)	(0. 29)	(0.57)	(0.57)	(0.58)	(0.54)
Number of obs	1224	10650	7766	7817	7817	7880
Log pseudo likelihood	-7329.82	-5926.5	-4414.2	-4451	-4446.5	-4494.4
Pseudo R2	0.02	0.08	0.08	0.08	0.08	0.08

Note: The dependent variable is a dummy if litigants settled or probably settled. Logit regressions with year dummies are not shown. Robust standard errors are in parentheses. Leverage is defined as a sum of long term debt and short term debt divided by sum of long term debt, short term debt , and total stockholder equity.

*Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level

Table 5.4 shows the estimates for the probability of a settlement for plaintiff litigants. Size measures for plaintiffs are negatively related to the probability of a settlement. The coefficients for the log of employment in columns 5 and 6 are -0.17 and -0.9, respectively. The coefficient of the log of total assets is -0.16 in all regressions and is significantly greater than zero. One likely explanation is that large firms are willing to create a threat in their market by pursuing a non-cooperative solution. This increases the costs for small firms and therefore discourages them from engaging in effective R&D activities.

The coefficients of the log of R&D spending per employee are negative and are highly significant in all specifications. Some plaintiffs which invest more on R&D may decide not to settle a dispute and will instead look for a greater damage award through the trial courts. The regressions in columns 2, 3, and 5 include the log of market value of equity per employee. The coefficients on the second and third regressions are negative and are significantly different from zero. The coefficient on leverage is negative and significantly greater than zero. Highly leveraged plaintiffs pursue a non-cooperative solution to earn damage awards or a higher settlement transfer at trial. The coefficient of the profit margin is negative. The coefficients on the current ratio are positive and are significant in all specifications. These results suggest that a high degree of liquidity eliminates delays in the settlement process.

Table 5.4: Regression for Probability of Settlement- Plaintiffs

Logit regressions for probability of settlement-Plaintiffs						
Dependent Variable: Settled & Probability Settled	1	2	3	4	5	6
Ln Mkt Value/employee		-0.16***	-0.14***			-0.14***
		(0.03)	(0.04)			(0.04)
Ln R&D/employee			-0.06**	-0.12***	-0.18**	-0.12***
			(0.03)	(0.03)	(0.03)	(0.03)
Leverage		-0.50***	-0.75***			
		(0.21)	(0.25)			
Current ratio (current asset/current liability)		0.05***	0.05***	0.04***	0.03***	0.05***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Profit Margin				-0.01*	-0.01*	-0.01*
				(0.01)	(0.01)	(0.01)
Ln Total Asset		-0.16***	-0.16***	-0.16***		
		(0.01)	(0.01)	(0.01)		
Ln employee					-0.17***	-0.16***
					(0.01)	(0.01)
Chemicals (SIC:28)	-0.40***	-0.39**	-0.1	-0.09	-0.09	-0.16
	(0.15)	(0.17)	(0.20)	(0.20)	(0.20)	(0.20)
Machinery (SIC:35)	-0.25	-0.53***	-0.23	-0.11	-0.02	-0.16
	(0.15)	(0.17)	(0.20)	(0.20)	(0.20)	(0.20)
Electronics (SIC:36)	-0.09	-0.28**	0.01	0.11	0.21	0.11
	(0.12)	(0.14)	(0.17)	(0.16)	(0.16)	(0.17)
Instruments (SIC:38)	-0.13	-0.51***	-0.24	-0.14	-0.04	-0.11
	(0.12)	(0.14)	(0.17)	(0.16)	(0.16)	(0.17)
Business services (SIC:73)	-0.43*	-1.16***	-1.16***	-1.08***	-1.02***	-1.13***
	(0.24)	(0.27)	(0.39)	(0.39)	(0.39)	(0.40)
Drugs/Pharmaceuticals (SIC:283)	-0.001***	-0.001***	-0.0001	-0.0002	-0.00002	-0.00005
	0.00	0.00	0.00	0.00	0.00	0.00
Computers (SIC:357)	-0.15	-0.23	0.07	0.18	0.26	0.16
	(0.14)	(0.16)	(0.18)	(0.18)	(0.18)	(0.18)
Computer programming/Software (SIC: 737)	-0.04	-0.35**	-0.05	0.06	0.16	0.09
	(0.13)	(0.16)	(0.18)	(0.18)	(0.18)	(0.18)
Manufacturing (SIC 20-39)	-0.26**	-0.42***	-0.22	-0.22	-0.19	-0.26
	(0.12)	(0.14)	(0.18)	(0.18)	(0.18)	(0.18)
Retail and wholesale (SIC: 50-59)	-0.04	-0.42**	-0.53	-0.62	-0.58	-0.55
	(0.19)	(0.21)	(0.51)	(0.44)	(0.44)	(0.50)
Finance, insurance and real estate (SIC:60-67)	-0.07	-0.69*	-0.66	-0.92	-0.81	-0.74
	(0.20)	(0.39)	(0.64)	(0.66)	(0.66)	(0.66)
Number of obs	10942	9468	7501	7840	7840	7399
Log pseudo likelihood	-4702.4	-4000.3	-3427.5	-3544	-3554.5	-3420
Pseudo R2	0.14	0.13	0.12	0.13	0.13	0.12

Note: The dependent variable is a dummy if litigants settled or probably settled. Logit regressions with year dummies are not shown. Robust standard errors are in parentheses. Leverage is defined as a sum of long term debt and short term debt divided by sum of long term debt, short term debt , and total stockholder equity.
*Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level

Table 5.5 combines plaintiffs' and defendants' characteristics and investigates the settlement behavior of litigants simultaneously. Size measures, the log of total assets and the log of the number of employees, are clearly positive and are highly significant in all regressions. The main determinant of the settlement is the litigant scale. Profitability measures, profit margin for plaintiffs and return on equity for defendants, turned out to be of small magnitude and were insignificant in all regressions. The coefficient of plaintiff's current ratio is negative and is significant in regressions 3, 4 & 6. Conversely, the coefficient of defendant's current ratio is positive and is significant in regressions 4 & 6. This suggests that plaintiffs may be willing to settle when they have a restricted liquidity whereas defendants are obviously willing to settle quickly when they have liquidity ability. My results suggest that a high level of defendant's liquidity and a low level of plaintiff liquidity promote the settlement process.

The coefficient of the plaintiff leverage ratio is negative and highly significant. This suggests that highly leveraged defendants are less likely to settle and this maybe because of either a failure in settlement negotiations or because of defendants who wished to prove patent invalidity via filing a counter-suit.

The coefficients of the log of plaintiff R&D spending per employee are positive in all regressions but not significantly different from zero. The coefficients of the log of defendant's R&D spending per employee are positive in regressions 4, 5, & 6 and significant. The coefficient of the log of market value per employee is positive for both

litigants. The main determinants of the settlement are the firms' scale and their liquidity level.

Table 5.5: Regression for Probability of Settlement- Plaintiffs & Defendants

Logit regressions for probability of settlement- Plaintiffs & Defendants												
Dependent Variable: Settled & Probability Settled	1		2		3		4		5		6	
Plaintiff Characteristics												
Ln Mkt Value/employee			0.06	(0.07)	0.12	(0.09)					0.18**	(0.09)
Ln R&D/employee					0.01	(0.11)	0.10	(0.1)	0.11	(0.1)	0.06	(0.11)
Leverage			-0.34**	(0.14)	-0.28***	(0.1)						
Current ratio (current asset/current liability)			0.00	(0)	-0.09***	(0.03)	-0.07**	(0.03)	-0.01	(0.01)	-0.08**	(0.03)
Profit Margin							0.002	(0.002)	0.002	(0.003)	0.002	(0.002)
Ln Total Asset			0.09***	(0.03)	0.12***	(0.04)	0.13***	(0.04)				
Ln employee									0.17***	(0.04)	0.14***	(0.04)
Defendant Characteristics												
Ln Mkt Value/employee					-0.03	(0.09)	0.13***	(0.05)			0.04	(0.09)
Ln R&D/employee			0.09	(0.07)	0.16	(0.11)	0.16*	(0.1)	0.27***	(0.09)	0.21*	(0.11)
Leverage			0.33**	(0.14)	0.28***	(0.1)			0.00	(0.01)		
Current ratio (current asset/current liability)			-0.01	(0.01)	0.05	(0.03)	0.05*	(0.03)			0.06**	(0.03)
Return on Equity							0.00	(0)	0.00*	(0)	0.00	(0)
Ln Total Asset			0.34***	(0.03)	0.32***	(0.04)						
Ln employee							0.33***	(0.04)	0.31***	(0.04)	0.33***	(0.04)
Industry Group												
Chemicals (SIC:28)	-0.04	(0.24)	-0.25	(0.32)	-1.92***	(0.47)	-1.50***	(0.42)	-1.50***	(0.42)	-1.91***	(0.47)
Machinery (SIC:35)	0.04	(0.22)	0.39	(0.27)	-0.71**	(0.37)	-0.76**	(0.36)	-0.76**	(0.36)	-0.84**	(0.36)
Electronics (SIC:36)	0.56***	(0.15)	0.75***	(0.2)	-0.62*	(0.32)	-0.65**	(0.31)	-0.65**	(0.31)	-0.79***	(0.32)
Instruments (SIC:38)	0.46***	(0.16)	0.97***	(0.2)	-0.40	(0.33)	-0.49	(0.31)	-0.49	(0.31)	-0.60*	(0.32)
Business services (SIC:73)	0.27	(0.43)	0.35	(0.69)	0.01	(1.13)	0.33	(0.96)	0.33	(0.96)	0.33	(0.94)
Drugs/Pharmaceuticals (SIC:283)	0.43***	(0.15)	0.46**	(0.2)	-1.04***	(0.34)	-1.05***	(0.33)	-1.05***	(0.33)	-1.19***	(0.33)
Computers (SIC:357)	0.31*	(0.17)	0.55**	(0.22)	-0.96***	(0.34)	-0.98***	(0.33)	-0.98***	(0.33)	-1.10***	(0.33)
Computer programming/Software (SIC: 737)	0.32**	(0.17)	0.59***	(0.21)	-0.63*	(0.33)	-0.73**	(0.33)	-0.73**	(0.33)	-0.83***	(0.33)
Manufacturing (SIC 20-39)	-0.24	(0.17)	-0.28	(0.22)	-1.61***	(0.37)	-1.44***	(0.35)	-1.44***	(0.35)	-1.60***	(0.35)
Retail and wholesale (SIC: 50-59)	-0.79***	(0.22)	-0.47*	(0.27)	-0.97	(0.63)	-0.85	(0.61)	-0.85	(0.61)	-0.89	(0.6)
Finance, insurance & real estate (SIC:60-67)	0.37*	(0.22)	1.39***	(0.4)	-0.41	(1.45)	-0.32	(1.48)	-0.32	(1.48)	-0.39	(1.57)
Number of obs	7992		6919		4858		4800		4793		4765	
Log pseudo likelihood	-3004		-2052		-1574		-1635		-1646		-1582	
Pseudo R2	0.05		0.21		0.20		0.19		0.18		0.19	

Note: The dependent variable is a dummy if litigants settled or probably settled. Logit regressions with year dummies are not shown. Robust standard errors are in parentheses. Leverage is defined as a sum of long term debt and short term debt divided by sum of long term debt, short term debt , and total stockholder equity.
*Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level

The coefficients of determination, Pseudo R^2, in Table 5.5 significantly improved in all variations compared to all regression models in Tables 5.3 & 5.4. This implies that combining both plaintiffs' and defendants' characteristics in a single model results in a better fit of the models.

Table 5.6 extends Table 5.4 by adding patent characteristics to plaintiffs 'firms level characteristics. Valuable patents are litigated more than other patents, so by adding patent characteristics to the models, different perspectives of settlement negotiation interactions among litigants can be evaluated. The coefficients of the log of patent portfolio per R&D spending are positive and are significant at 5% in regressions 1, 3, & 5. The likelihood of settlement increases with patent yields for R&D intensive firms. As firms invest more in new technology, the cooperative solution for litigants increases their joint profits and decreases uncertainty for both parties. The log of backward citations and the log of forward citations turn out to be positive and are only significant for backward citations. As measures of patent quality, a higher number of backward citations and forward citations increase the likelihood of settlement and promote dispute negotiations. Originality and generality measures turn out to be small in magnitude and insignificant in most of the variations. The log of R&D per employee is positive and is highly significant in regressions 1, 3, & 5. The log of market value per employee and the log of sales are positive and significant.

Table 5.6: Regression for Probability of Settlement after Filing Lawsuit- Plaintiffs

Logit regressions for probability of settlement after filing a lawsuit-Plaintiffs										
Dependent Variable: Settled or probably settled										
	1		2		3		4		5	
Plaintiff Characteristics										
Ln Capital Exp/employee					0.05	(0.05)	0.07	(0.05)	0.05	(0.05)
Ln R&D/employee	0.04**	(0.02)	-0.03	(0.04)	0.04**	(0.02)	-0.04	(0.04)	0.04***	(0.02)
Ln Mkt Value/employee	0.06*	(0.03)	0.08**	(0.04)	0.03	(0.04)	0.05	(0.04)	0.04	(0.04)
Ln Sales	0.12***	(0.02)	0.11***	(0.02)	0.13***	(0.02)	0.11***	(0.02)	0.12***	(0.02)
Current ratio (current asset/current liability)									-0.03*	(0.01)
Patent Characteristics										
Ln Pat Portfolio/R&D	0.05**	(0.03)	0.03	(0.03)	0.06**	(0.03)	0.03	(0.03)	0.06**	(0.03)
Ln Forward Cites/ Pat Portfolio	0.03	(0.03)	0.03	(0.04)	0.03	(0.03)	0.04	(0.04)	0.03	(0.04)
Ln Backward Cites/ Pat Portfolio	0.07**	(0.03)	0.13***	(0.05)	0.06**	(0.03)	0.13***	(0.05)	0.07**	(0.03)
Originality	-0.001	(0.001)	-0.001	(0.001)	-0.001*	(0.001)	-0.001	(0.001)	-0.001*	(0.001)
Generality	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)
D (R&D=0)			0.29*	(0.15)			0.31**	(0.16)		
D (Pat Portfolio=0)			-0.69*	(0.38)			-0.80**	(0.39)		
Number of obs	4775		4775		4713		4713		4639	
Log pseudo likelihood	-2888.1		-2884.9		-2849.1		-2845.3		-2793.1	
Pseudo R2	0.12		0.12		0.12		0.12		0.13	

Note: The dependent variable is a dummy if a plaintiff settled or probably settled. Logit regressions with year dummies and industry dummies are not shown.
Robust standard errors are in parentheses.
*Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level

The plaintiff's current ratio is negatively correlated with the settlement rate. One likely explanation is that high leverage firms, with a low level of liquidity, settle quickly in order to take advantage of the settlement transfer or license fee. The main determinants of settlement are plaintiff's scale, R&D intensity, current ratio, patent yield, and backward citations.

Table 5.7 completes Table 5.6 by adding defendants' characteristics, separately and together with plaintiffs' characteristics, to regression models. This combination enables us to rigorously compare the behavior of litigants in settled suits. In my analysis, consent judgments, stipulated dismissals, and voluntary dismissals were all considered as probably settled suits. Although there are few suits that are "probably settled" in my sample, I estimate them separately in Columns 2, 4, & 6 in Table 5.7. My results demonstrate that there is no significant difference in magnitude or signs of coefficients in all regressions in *settled* sample or in *probably settled* sample.

My results in column 1 & 2 are similar to the results in regression 6 in Table 5.6. The coefficients of the log of capital expenditures to R&D spending for defendants are -0.08 in regressions 3 and 4 and, are significant at 10% only for regression 4. The log of defendant's sales turns out to be positive and is highly significant in regressions 3 and 4. The coefficients of defendant's sales are higher in magnitude than plaintiff's sales, which suggest that the likelihood of a settlement is affected more by the defendant's size than the plaintiff's size. Defendants settle

quickly mainly because of litigation costs and reputation concerns. Capital intensity, scale, and liquidity level are the main determinants of settlement.

The last two regressions in Table 5.7 combine the defendants' and plaintiffs' characteristics together with patent characteristics. Capital-intensive firms as defendants are more in danger of patent injunctions, and therefore settle more quickly to avoid injunction. Unlike the positive coefficient of the defendant's capital intensity, the coefficient of the log of capital expenditures to employees for the plaintiff is negative and is highly significant. This may suggest that capital-intensive plaintiffs refuse to settle in order to request an order of injunctive relief and impose a holdup risk for alleged infringers. The positive coefficient of the plaintiff's R&D intensity suggests a cooperative interaction of plaintiffs to settle a dispute. The negative coefficient of the defendant's R&D intensity suggests that alleged infringers with a high innovation investment are looking to prove patent invalidity. The log of Sale measures as proxy for firm size turns out to be positive and is significant for both litigants, which suggest that scale matters in settlement negotiations and enhances the dispute process.

The log of plaintiff's current ratio is negatively correlated with the probability of settlement while the log of defendant's current ratio is positively correlated with the probability of settlement. As the liquidity level of defendants increases and the liquidity of plaintiffs decreases, the probability of cooperative interaction between

litigants increases. Most of the measures of patent quality are positively correlated with the settlement rate, but most of them are not significantly different from zero.

My results represent that the influential determinants of cooperative solutions via settlement mechanism are capital intensity, R&D intensity, scale, liquidity level, patent yield and the quality of patents.

Table 5.7: Regressions for Probability of Settlement-Plaintiffs & Defendants

Logit regressions for probability of settlement-Plaintiffs & Defendants												
	Dependent Variable											
	Plaintiffs				Defendants				Plaintiffs & Defendants			
	Settled		Settled & probably settled		Settled		Settled & probably settled		Settled		Settled & probably settled	
	1		2		3		4		5		6	
Plaintiff Characteristics												
Ln Capital Exp/employee	-0.06	(0.05)	0.05	(0.05)					-0.14***	(0.04)	-0.08**	(0.04)
Ln R&D/employee	0.05***	(0.02)	0.04***	(0.02)					0.12***	(0.04)	0.08***	(0.03)
Ln Mkt Value/employee	0.05	(0.04)	0.04	(0.04)					0.01	(0.03)	0.01	(0.02)
Ln Sales	0.10***	(0.02)	0.12***	(0.02)					0.17***	(0.04)	0.19***	(0.04)
Current ratio (current asset/current liability)	-0.02	(0.01)	-0.03*	(0.01)					-0.08***	(0.03)	-0.06**	(0.03)
Defendant Characteristics												
Ln Capital Exp/employee					-0.08	(0.05)	-0.08*	(0.05)	0.11**	(0.04)	0.06*	(0.04)
Ln R&D/employee					0.01	(0.05)	-0.01	(0.04)	-0.05	(0.03)	-0.05**	(0.02)
Ln Mkt Value/employee					-0.01	(0.04)	-0.04	(0.04)	-0.03	(0.02)	-0.02	(0.02)
Ln Sales					0.13***	(0.03)	0.16***	(0.02)	0.08**	(0.03)	0.05	(0.03)
Current ratio (current asset/current liability)					-0.0003	(0.02)	-0.004	(0.02)	0.06***	(0.02)	0.03	(0.02)
Patent Characteristics												
Ln Pat Portfolio/R&D	0.08***	(0.03)	0.06**	(0.03)	0.01	(0.03)	0.02	(0.03)	0.03	(0.05)	0.01	(0.04)
Ln Forward Cites/ Pat Portfolio	0.03	(0.04)	0.03	(0.04)	0.04	(0.04)	0.06	(0.04)	0.04	(0.06)	0.02	(0.05)
Ln Backward Cites/ Pat Portfolio	0.06*	(0.04)	0.07**	(0.03)	0.09*	(0.05)	0.05	(0.05)	0.1	(0.09)	0.15**	(0.07)
Originality	0.0002	(0.0006)	-0.001*	(0.001)	0.0003	(0.0005)	0.0001	(0.0005)	0.001	(0.001)	0.0003	(0.001)
Generality	-0.0004	(0.0009)	0.001	(0.001)	-0.0003	(0.0008)	-0.0001	(0.0008)	-0.003	(0.002)	-0.001	(0.001)
Number of obs	4615		4639		4229		4234		2770		2774	
Log pseudo likelihood	-2408.8		-2793.1		-2372.4		-2745.5		-1129.7		-1431.8	
Pseudo R2	0.06		0.10		0.03		0.04		0.10		0.12	

Note: The dependent variable is a dummy if litigans "settled" or "settled & probably settled". Logit regressions with year dummies and industry dummies are not shown.
Dummies for "No R&D firms" and "No Patent firms" are not shown too. Robust standard errors are in parentheses.
*Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level

5.1.3 Regression Analysis of Injunction

Table 5.8 estimates the probability of granting injunctions for all public litigants from 1996 to 2010. Regression 1 shows the estimates for plaintiff firms. The coefficient of the log of backward citations per patent portfolio is 0.3 and is significant at a 1% confidence level which is five times greater than the settled model in Table 5.7 in regression 1. The originality coefficient is negative and is significant at a 5% confidence level while the generality coefficient is positive and is significant at a 5% confidence level. As the patent litigation literature suggests, valuable patents have a high score of generality and a low score of originality. Also, the coefficient of the log of patent portfolio per R&D spending and the log of forward citations per patent portfolio turn out with positive signs, but not significantly different from zero. All this evidence suggests a positive correlation between granting an order of injunction and patent quality. My results provide clear evidence that the strongest determinant of being granted an order of injunction is patent characteristics.

The coefficient of the log of sale is positive and significant. Larger plaintiffs have more capability to present evidence to avoid "irreparable harm." In addition, larger plaintiffs impose financial pressure on their rivals and create threat points in their market by requesting and seeking to receive an order of injunctive relief.

The coefficient of the current ratio turns out positive and significant at a 10% confidence level. My findings indicate that injunction being granted is more common in suits where the plaintiffs had greater sales and greater liquidity.

Regression 2 reports estimates for defendant firms. Most of our estimates turn out not significantly different from zero, except defendant's current ratio which is negative and significant at a 5% confidence level. Regression 3 reports estimates from both litigants' characteristics together with patent characteristics. The plaintiff's capital intensity is negatively correlated with the injunction rate, and R&D intensity positively increases the likelihood of being granted a preliminary injunction. This result makes sense because firms with a low level of capital expenditures invest relatively more on R&D, which resulted in more innovation than a typical capital-intensive firm. Consequently, R&D-intensive firms strongly enforce their patent rights via an injunction mechanism. The log of plaintiff sales is 1.12 and is significant at a 1% confidence level. The plaintiff's current ratio is 0.61 and significant at a 1% confidence level. Similar to results in regression 1, injunctions being granted are more common in suits where the plaintiffs had greater sales and a greater liquidity level. The only significant coefficient in regression 2 is the current ratio which is negatively correlated with the injunction rate. This suggests that as defendants' liquidity levels increase, the defendants' ability to defend themselves in court against an order of injunction increases.

The log of patent portfolio per R&D spending is 0.83 and is significant at a 5% confidence level. Firms with a high yield of patents per R&D investment are actively requesting injunctions. As expected, originality is negatively correlated with the injunction rate, and generality is positively correlated with the injunction rate. Both measures are significant at a 1% confidence level. As patent litigation literature suggests, valuable patents have a low score of originality and a high score of generality. Therefore, the granting of a preliminary injunction by court increases proportionally with the quality of the patents portfolio, consistent with hypothesis 3b.

In conclusion, the dominant factors of granting an order of injunction are dominated by plaintiffs' characteristics and their patent characteristics rather than defendants' characteristics. Defendants' characteristics have little influence in preventing injunctions. The influential determinants of being granted injunctions are capital intensity, R&D intensity, scale, liquidity level, patent yield, and measures of generality and originality.

Table 5.8: Logit Regressions for Probability of Granting Injunction- Plaintiffs, Defendants, and Patents

Logit regressions for probability of granting injunctions-Plaintiffs & Defendants						
Dependent Variable: Injunctions						
	1		2		3	
Plaintiff Characteristics						
Ln Capital Exp/employee	-0.14	(0.14)			-0.61***	(0.2)
Ln R&D/employee	-0.07	(0.06)			0.55**	(0.25)
Ln Mkt Value/employee	0.2	(0.13)			-0.06	(0.1)
Ln Sales	0.12*	(0.08)			1.12***	(0.35)
Current ratio (current asset/current liability)	0.06*	(0.03)			0.61***	(0.19)
Defendant Characteristics						
Ln Capital Exp/employee			0.14	(0.25)	0.24	(0.24)
Ln R&D/employee			-0.16	(0.18)	-0.23	(0.19)
Ln Mkt Value/employee			-0.03	(0.16)	0.12	(0.11)
Ln Sales			0.05	(0.15)	0.02	(0.12)
Current ratio (current asset/current liability)			-0.23*	(0.12)	-0.52***	(0.14)
Patent Characteristics						
Ln Pat Portfolio/R&D	0.08	(0.1)	0.18	(0.18)	0.83**	(0.36)
Ln Forward Cites/ Pat Portfolio	0.03	(0.15)	-0.14	(0.2)	-0.25	(0.37)
Ln Backward Cites/ Pat Portfolio	0.30***	(0.11)	0.005	(0.31)	0.41	(0.31)
Originality	-0.01**	(0.01)	-0.004	(0.003)	-0.04***	(0.02)
Generality	0.02**	(0.01)	0.002	(0.003)	0.05***	(0.02)
Number of obs	3923		3235		1052	
Log pseudo likelihood	-297.8		-130.4		-50.5	
Pseudo R2	0.09		0.08		0.28	

Note: The dependent variable is a dummy if a court granted an order of injunction. Logit regressions with year dummies and industry dummies are not shown. Dummies for "No R&D firms" and "No Patent firms" are not shown too. Robust standard errors are in parentheses.

*Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level

Table 5.9 estimates the probability of going to trial for all public litigants from 1996 to 2010. Regression 1 shows estimates of plaintiffs' characteristics together with their patent characteristics. The log of market value per employee is 0.67 and is highly significant. The current ratio is -0.36 and is significant at a 1% confidence level. The log of sales is also positively correlated with the probability of going to trial court. These results suggest that larger firms with a low level of liquidity are looking for an opportunity in trial court by refusing to settle prior to trial.

Regression 2 presents an estimate of defendants' characteristics with plaintiffs' patent characteristics. All coefficients turn out not to be significantly different from zero. The last column reports estimates for both litigants. Most coefficients turn out to be insignificant, except the litigant's size. My results provide evidence that larger plaintiffs seek going to trial while small defendants try to avoid trial court due to the cost of litigation. Most measures of patent quality in all regressions are insignificant and do not follow the expected signs.

My findings suggest that the dominant determinant of the probability of going to trial court is the litigant's scale. Larger firms impose greater stakes for smaller defendants by refusing to settle prior to trial. Larger plaintiffs look for a winning opportunity at trial and receive damage awards or ask for higher settlement amounts during the trial process.

Table 5.9: Logit Regressions for Probability of Going to Trial Court - Plaintiffs, Defendants, ad Patents

Logit regressions for probability of pursuing at trial court-Plaintiffs & Defendants						
Dependent Variable: if a case pursued at trial						
	1		2		3	
Plaintiff Characteristics						
Ln Capital Exp/employee	0.0002	(0.24)			-0.04	(0.14)
Ln R&D/employee	-0.03	(0.1)			-0.11	(0.12)
Ln Mkt Value/employee	0.67***	(0.2)			0.04	(0.08)
Ln Sales	0.16*	(0.1)			0.55**	(0.29)
Current ratio (current asset/current liability)	-0.36***	(0.14)			-0.05	(0.27)
Defendant Characteristics						
Ln Capital Exp/employee			-0.2	(0.22)	-0.01	(0.12)
Ln R&D/employee			0.04	(0.19)	-0.01	(0.09)
Ln Mkt Value/employee			0.26	(0.18)	0.02	(0.05)
Ln Sales			0.06	(0.08)	-0.23*	(0.13)
Current ratio (current asset/current liability)			-0.16	(0.12)	-0.26	(0.19)
Patent Characteristics						
Ln Pat Portfolio/R&D	-0.01	(0.1)	-0.04	(0.11)	0.08	(0.16)
Ln Forward Cites/ Pat Portfolio	0.14	(0.15)	-0.25	(0.17)	0.26	(0.34)
Ln Backward Cites/ Pat Portfolio	0.05	(0.14)	0.02	(0.21)	-0.27	(0.4)
Originality	0.002	(0.002)	0.002	(0.002)	-0.0003	(0.002)
Generality	-0.002	(0.004)	-0.002	(0.003)	-0.001	(0.004)
Number of obs	4340		3803		2156	
Log pseudo likelihood	-294.3		-242.9		-107.3	
Pseudo R2	0.16		0.12		0.16	

Note: The dependent variable is a dummy if litigants going to trial court. Logit regressions with year dummies and industry dummies are not shown. Dummies for "No R&D firms" and "No Patent firms" are not shown too. Robust standard errors are in parentheses.
*Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level

Table 5.10 reports estimates of various court outcomes at trial. The dependent variable is a dummy and takes the value of one if (1) plaintiff wins a lawsuit, (2) defendants win a lawsuit, or (3) plaintiffs win a lawsuit and are entitled to damage awards. The first two regressions show estimates from litigants when plaintiffs win a lawsuit case at trial. The log of plaintiff's capital expenditures per employee is positive

and is significant at a 1% confidence level. Similarly, the coefficient of capital intensity in regression 5 is positive and significant, demonstrating the fact that capital-intensive firms 'target is to win at trial and receive damage awards. My findings in Table 5.7 also suggest that capital-intensive plaintiffs refuse to settle in order to request injunctions and impose a holdup risk for the alleged infringers. My results in Table 5.10 are consistent with prior findings in Table 5.7 regarding plaintiff's capital intensity. Capital-intensive plaintiffs refuse to settle in order to continue at trial and win a lawsuit and receive damage awards. The log of the plaintiff's market value per employee in regression 1 is positive and is significant at a 10% confidence level.

The log of plaintiff's sales in regression 1 and 2 are positive and highly significant. The log of plaintiff's R&D spending is positive in regression 2 and significant at a 10% confidence level. By looking at defendant's characteristics in regression 2, it is obvious that capital-intensive firms with a high market value are more often targeted by plaintiffs. Small defendants with a low level of R&D investment are less likely to win a lawsuit.

The estimates of patent characteristics in regression 1 demonstrate that the holders of valuable patents are more likely to win a lawsuit than others, consistent with hypothesis 3a. The log of patent portfolio per R&D spending is 0.11 and is highly significant, suggesting that patent intensive plaintiffs look to win at trial by refusing to settle. The log of backward citations, as a proxy for patent quality, is positive and significant at a 5% confidence level. As expected, originality is inversely correlated

with the likelihood of winning at trial while originality is positively correlated with the likelihood of winning at trial. Both measures are highly significant at a 1% confidence level. My results provide strong evidence and support for hypothesis 3a, which demonstrates that the plaintiff win rates proportionally increase with the quality of the patents portfolio.

The influential determinants of winning at trial are capital intensity, R&D intensity, Market value per employee, and scale for both litigants in addition to patent yield and measures of originality, generality, and forward and backward citations.

Table 5.10: Logit Regressions for Probability of Different Court Trial Outcomes- Plaintiffs, Defendants, Patents

Logit regressions for probability of different trial court outcomes-Plaintiffs & Defendants														
	Dependent Variable													
	Plaintiff Win				Defendant Win				Damages Awarded to Plaintiffs					
	1		2		3		4		5		6		7	
Plaintiff Characteristics														
Ln Capital Exp/employee	0.30***	(0.1)	-0.04	(0.07)			-0.05	(0.08)	0.31**	(0.16)			-0.08	(0.11)
Ln R&D/employee	0.01	(0.03)	0.12*	(0.07)			0.08	(0.07)	0.12	(0.08)			0.23*	(0.12)
Ln Mkt Value/employee	0.12*	(0.07)	-0.02	(0.05)			-0.09**	(0.04)	-0.05	(0.14)			0.10*	(0.06)
Ln Sales	0.13***	(0.04)	0.39***	(0.07)			0.13	(0.09)	0.07	(0.08)			0.11	(0.2)
Current ratio (current asset/current liability)	-0.01	(0.03)	0.04	(0.05)			-0.28***	(0.1)	-0.04	(0.05)			-0.15	(0.12)
Defendant Characteristics														
Ln Capital Exp/employee			0.20***	(0.07)	0.00	(0.09)	0.08	(0.07)			-0.15	(0.18)	0.08	(0.11)
Ln R&D/employee			-0.13**	(0.06)	-0.01	(0.08)	-0.07	(0.05)			0.06	(0.19)	-0.01	(0.13)
Ln Mkt Value/employee			0.09**	(0.05)	0.24***	(0.07)	0.12***	(0.04)			-0.002	(0.12)	0.05	(0.08)
Ln Sales			-0.25***	(0.06)	0.11**	(0.05)	0.04	(0.07)			0.12	(0.09)	0.04	(0.14)
Current ratio (current asset/current liability)			-0.04	(0.05)	-0.03	(0.04)	0.03	(0.03)			0.05**	(0.02)	0.11***	(0.04)
Patent Characteristics														
Ln Pat Portfolio/R&D	0.11**	(0.05)	-0.03	(0.1)	-0.03	(0.05)	-0.01	(0.09)	0.05	(0.08)	0.03	(0.1)	-0.05	(0.21)
Ln Forward Cites/ Pat Portfolio	-0.07	(0.07)	0.17	(0.15)	0.09	(0.08)	0.36***	(0.13)	-0.1	(0.11)	0.33*	(0.19)	0.01	(0.26)
Ln Backward Cites/ Pat Portfolio	0.12**	(0.06)	0.13	(0.21)	0.24***	(0.09)	0.46***	(0.17)	0.07	(0.11)	0.46**	(0.2)	0.48*	(0.27)
Originality	-0.01***	(0.002)	-0.01**	(0.005)	-0.001	(0.001)	0.001	(0.001)	-0.01	(0.004)	0.001	(0.002)	-0.02	(0.01)
Generality	0.01***	(0.003)	0.01***	(0.01)	0.002	(0.001)	-0.001	(0.003)	0.01	(0.005)	0.00	(0.003)	0.02	(0.01)
Number of obs	4634		2641		4231		2753		4529		4116		1752	
Log pseudo likelihood	-1037.2		-310.9		-1035.5		-407.5		-399.0		-287.0		-113.6	
Pseudo R2	0.10		0.19		0.06		0.12		0.18		0.07		0.19	

Note: The dependent variable is a dummy for the different trial court outcomes. Logit regressions with year dummies and industry dummies are not shown.
Dummies for "No R&D firms" and "No Patent firms" are not shown either Robust standard errors are in parentheses.
*Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level

Regressions 3 and 4 show estimates from litigants when defendants win a lawsuit. The log of defendant's market value per employee in both regressions is positive and highly significant. Conversely, plaintiff's market value per employee, shown in regression 4, is negative and significant at a 5% confidence level. Moreover, plaintiff's current ratio in regression 4 is negative and highly significant. This pattern demonstrates that larger defendants can better handle litigation costs and are more likely to win at trial. The coefficient of the log of plaintiff's patent portfolio per R&D spending is negative and insignificant, which suggests that the weak outcomes of patents yield per R&D spending for plaintiffs lead to inefficient "defensive patent strategy." There are three main reasons that plaintiffs lose at trial: (1) defendant's ability to better handle litigation costs by employing more experienced patent lawyers, (2) the inability of plaintiffs to demonstrate the value of infringed patents due to litigation costs, and (3) inefficient "plaintiff's defensive patent strategy."

The last three regressions represent estimates from litigants when plaintiffs win a lawsuit case and receive damage awards at trial. The coefficient of the log of plaintiff's R&D per employee is 0.23 and significant at a 10 % confidence level which is two times greater in magnitude than regression 2, suggesting that plaintiffs increase their efforts to win at trial and receive damage awards when they invest more on R&D. The defendant's current ratio is positive in regressions 6 and 7 and is highly significant, suggesting that plaintiffs target higher liquid defendants. The coefficient of the log of

patent portfolio per R&D spending is positive in regressions 5 and 6, but not significantly different from zero.

There are two reasons to explain why plaintiffs win at trial and receive damage awards: (1) plaintiff's capability to handle litigation costs better than defendants, and (2) having higher-quality patent portfolio.

5.2 Selection Models: Analysis of Size Effects

The statistics in Table 3.1 indicate that litigation imposes a much larger pressure on minor patentees who generate 4.3 patents per year, on average, compared to major patentees who generate 94.4 patents per year, on average. Lanjouw and Lerner (2001) assert that reputational considerations of litigiousness could explain the relationship between the financial characteristics of litigants and court actions. Lanjouw and Schankerman (2004) provide evidence that there are substantial differences in litigation rates by the size of litigants. Lanjouw and Lerner (2001) state that "the importance of creating and maintaining a reputation for litigiousness may increase when a firm expects to be engaged in future disputes." Larger firms are more likely expecting to be involved in the patent infringement since they have more patents. I provide a similar finding which affirms Lanjouw and Lerner's conclusion in Table 5.2. The positive coefficients of sales, as a proxy for firm size, and patent yield per R&D are the obvious evidence that litigation rates are higher for major patentees than minor patentees.

I present a selection model, motivated by Eisenberg and Farber (1997), to investigate how the selection process affects litigants' characteristics in suits filed in relationship to the distribution of patentees. I conduct my empirical analysis at two levels for minor and major patentees: (1) in a base model which includes plaintiffs 'characteristics and their patents characteristics, and (2) in a full model which includes defendants' characteristics to the base model. In this section, I test the hypotheses of my dissertation and show how dispersion in the distribution of plaintiffs' litigation costs affect various court outcomes (e.g. going to trial, winning at trial, and the granting of a preliminary injunction) among minor and major patentees.

5.2.1 Regression Analysis of Trial Rate

Table 5.11 reports an estimation of the probability of going to trial for minor and major patentees from 1996 to 2010. Regression models in columns 1 and 2 estimate the base models using plaintiffs' characteristics and patent characteristics, and regression models in columns 3 and 4 estimate the full models by adding defendants' characteristics to the base models. All models include dummies for years and industry groups as well as dummies for "No-R&D firms" and "No-patent firms." I performed a likelihood ratio test for both minor and major patentees to see if the base model or the full model provides a better fit for the data. The p-values from likelihood ratio tests for both small and large firms are less than 0.00001. Therefore, I can reject the null

hypothesis (H0: a base model or restricted model is true), and so the estimated full models provide a significantly better fit and more reliable predictions.

In column 3, the coefficient of patent yields per R&D turn out to be negative, -0.4, and the coefficient of log of backward citations per patent portfolio turn out to be -0.46, but not significantly different from zero. My results provide some evidence that lower-quality suits, among minor patentees, are more likely decide to pursue a trial. All coefficients of defendants' and plaintiffs' characteristics turn out to be insignificant among minor patentees.

The last column of Table 5.11 estimates the full model for major patentees. The coefficient of the plaintiff's market value per employee turns out to be negative and is significant at a 5 percent confidence level. The current ratio for major patentees is also negative and is relatively significant, suggesting that as the liquidity level of a patentee decreases, the likelihood of going to trial increases. One likely explanation is that major patentees decide to continue at trial when they are in financial trouble. They see trial court as an opportunity for two reasons: first, to increase their negotiation power and therefore look for higher settlement offer; and second, to increase the chances of winning at trial and receiving damage awards, providing valid patents. The positive coefficient of patents yield per R&D and forward citations support the earlier explanation about validity and quality of patents produced by larger firms. Major patentees are more likely to pursue a trial rather than settle if they are confident about their patent validity.

My results suggest that trial probability is not significantly related to the characteristics of the defendants. The mean predicted probability of a trial is 3.7 percent for major patentees and 2.2 percent for minor patentees in the base models, which is not consistent with hypothesis 1. My results in the full models suggest a similar pattern of predicted probabilities, but lower in magnitude. The mean predicted probability of a trial is 2.9 percent for major patentees and 0.8 percent for minor patentees in the full models. The results of both models are inconsistent with hypothesis 1. One explanation is that reaching the trial stage in a patent litigation lawsuit is still costly regardless of the size of firms, so minor patentees, particularly those who have lower-quality patents, prefer to settle before trial because their settlement payoffs are more than their expected payoffs at trial (net of litigation costs).

Table 5.11: Logit Regressions for Probability of Going to Trial among Small and Large Firms

Logit regressions for probability of trial at court for small and large corporations								
Dependent Variable: if a case pursued at trial	Small Firms		Large Firms		Small Firms		Large Firms	
	1		2		3		4	
Plaintiff Characteristics								
Ln Capital Exp/employee	0.05	(0.19)	-0.03	(0.06)	-0.21	(0.39)	0.02	(0.09)
Ln R&D/employee	-0.08	(0.2)	0.45***	(0.11)	0.38	(0.42)	0.09	(0.1)
Ln Mkt Value/employee	0.05	(0.04)	-0.01	(0.04)	0.13	(0.51)	-0.12**	(0.05)
Ln Sales	-0.05	(0.17)	0.13	(0.08)	-0.38	(0.66)	0.12	(0.13)
Current ratio (current asset/current liability)	-0.09	(0.07)	-0.17**	(0.08)	-0.2	(0.15)	-0.29*	(0.15)
Defendant Characteristics								
Ln Capital Exp/employee					0.63	(0.75)	-0.09	(0.12)
Ln R&D/employee					0.07	(0.17)	-0.1	(0.08)
Ln Mkt Value/employee					-0.09	(0.39)	0.11**	(0.06)
Ln Sales					0.61	(0.44)	-0.11	(0.09)
Current ratio (current asset/current liability)					0.17	(0.13)	-0.01	(0.05)
Patent Characteristics								
Ln Pat Portfolio/R&D	0.18	(0.19)	0.08	(0.08)	-0.4	(0.3)	0.19	(0.12)
Ln Forward Cites/ Pat Portfolio	-0.08	(0.25)	0.11	(0.09)	-0.46	(0.6)	0.56**	(0.23)
Ln Backward Cites/ Pat Portfolio	0.37	(0.31)	0.19	(0.13)	1.46***	(0.38)	0.15	(0.25)
Originality	0.02	(0.02)	-0.001	(0.001)	-0.99	(0.61)	-0.0003	(0.002)
Generality	-0.03	(0.07)	-0.0002	(0.003)	0.04	(0.41)	-0.002	(0.004)
Number of obs	854		3935		724		1887	
Log pseudo likelihood	-83.6		-579.0		-20.9		-215.5	
Pseudo R2	0.08		0.06		0.40		0.12	
Predicted probability at mean	0.022		0.037		0.008		0.029	

Note: The dependent variable is a dummy if a case pursued at trial court Robust standard errors are in parentheses.
Logit regressions with year dummies, industry dummies, and dummies for "No R&D firms" and "No Patent firms" are not shown.
*Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level

5.2.2 Regression Analysis of Win Rate

Table 5.12 contains maximum-likelihood estimates of the key parameters of the probability of winning at trial for minor and major patentees used in the logit models. Regression models in columns 1 and 2 are the base models for minor and major patentees. The mean predicted win probability for minor patentees is 4.8 percent in the base model whereas the mean predicted win probability for major patentees increases to

7.1 percent, consistent with hypothesis 2a. In Tables 5.14 and 5.15, I also provide some evidence that major patentees are more likely to win a lawsuit than minor patentees.

The lack of adequate observations prevents the estimation of a full model for minor patentees in Table 5.12. Column 3 reports the probability of a win for major patentees using both defendants' and plaintiffs' characteristics together with patent characteristics. The coefficient of defendant's capital expenditures turns out with a positive sign, and is highly significant, whereas, the coefficient of plaintiff's capital expenditures turns out with a negative sign, but is never significant. This implies that the probability of winning for large firms decreases with respect to their capital intensity while this probability increases with defendant's capital intensity. This means that capital-intensive defendants are more likely to lose a lawsuit. This result makes sense because firms with a higher level of capital expenditures invest relatively lesson R&D and are more likely to infringe other patents, advertently or inadvertently, than a typical R&D-intensive firm.

The coefficient of the defendant's R&D spending turns out to be -0.13, and is significant at a 10 percent confidence level. This suggests that defendants begin to infringe on patents to save on R&D investment. The coefficients on forward and backward citations and generality turn out with positive signs while the coefficient of originality is negative. Valuable patents have a high number of citations, a high score of generality, and a low score of originality. Therefore, my results suggest that higher-

quality patents have a higher chance of succeeding at trial. My results provide strong support for hypothesis 3a.

Table 5.12: Logit Regressions for Probability of Wining among Large and Small Firms

Logit regressions for probability of winning at court for small and large corporations						
Dependent Variable: Winning during litigation	Small Firms		Large Firms		Large Firms	
	1		2		3	
Plaintiff Characteristics						
Ln Capital Exp/employee	-0.04	(0.08)	0.11	(0.08)	-0.05	(0.07)
Ln R&D/employee	-0.07	(0.07)	0.00	(0.03)	0.08	(0.07)
Ln Mkt Value/employee	0.01	(0.05)	0.27***	(0.05)	0.04	(0.03)
Ln Sales	-0.04	(0.08)	0.04	(0.06)	0.20*	(0.12)
Current ratio (current asset/current liability)	-0.03	(0.04)	0.05	(0.04)	0.08	(0.08)
Defendant Characteristics						
Ln Capital Exp/employee					0.23***	(0.07)
Ln R&D/employee					-0.13**	(0.06)
Ln Mkt Value/employee					0.08*	(0.05)
Ln Sales					-0.30***	(0.06)
Current ratio (current asset/current liability)					-0.05	(0.05)
Patent Characteristics						
Ln Pat Portfolio/R&D	-0.05	(0.14)	0.06	(0.05)	-0.07	(0.12)
Ln Forward Cites/ Pat Portfolio	-0.52***	(0.2)	-0.01	(0.08)	0.31*	(0.16)
Ln Backward Cites/ Pat Portfolio	0.16	(0.12)	0.11*	(0.07)	0.02	(0.22)
Originality	-0.01	(0.02)	0.01***	(0.002)	-0.01	(0.01)
Generality	0.07	(0.06)	0.01	(0.003)	0.01*	(0.01)
Number of obs	1009		3986		1971	
Log pseudo likelihood	-169.8		-907.1		-274.2	
Pseudo R2	0.12		0.11		0.20	
Predicted probability at mean	0.048		0.071		0.042	

Note: The dependent variable is a dummy if a firm as a plaintiff wins during litigation. Robust standard errors are in parentheses. Logit regressions with year dummies, industry dummies, and dummies for "No R&D firms" & "No Patent firms" are not shown.
*Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level

5.2.3 Regression Analysis of Injunction

Table 5.13 contains estimates of probability that a judgment is entered on the granting of a preliminary injunction across large and small firms as patentees. The mean predicted probability of being granted an injunction by the court is almost the same among minor and major patentees. About 1.8 percent of filed lawsuit cases receive an order of injunctive relief. Many practitioners believe that an issuance of a preliminary injunction is more likely to lead to a permanent injunction at trial, and therefore for plaintiffs, the granting of a preliminarily injunction is equivalent to a win at trial. My results provide weak support for hypothesis 2b.

My results indicate that the characteristics of plaintiff firms and their patent characteristics are the main determinants of the granting of a preliminary injunction. The coefficient of patent yield per R&D is positive, 0.71, and is significant at a 5 percent confidence level. The coefficient of originality is negative while the coefficient of generality is positive, as expected, and both coefficients are highly significant. My findings provide strong support for hypothesis 3b in which higher-quality patents are more likely to receive an order of injunctive relief.

Table 5.13: Logit Regressions for Probability of Granting an Injunction among Large and Small Firms

Logit regressions for probability of injunction at court for large corporations						
Dependent Variable: Injunctions	Small Firms		Large Firms		Large Firms	
	1		2		3	
Plaintiff Characteristics						
Ln Capital Exp/employee	-0.05	(0.16)	-0.01	(0.06)	-0.73**	(0.36)
Ln R&D/employee	-0.36***	(0.14)	-0.13	(0.16)	0.57**	(0.25)
Ln Mkt Value/employee	0.16*	(0.09)	0.35***	(0.14)	-0.03	(0.19)
Ln Sales	-0.1	(0.2)	-0.09	(0.1)	0.89**	(0.42)
Current ratio (current asset/current liability)	0.03	(0.04)	0.09*	(0.06)	0.64***	(0.22)
Defendant Characteristics						
Ln Capital Exp/employee					0.19	(0.29)
Ln R&D/employee					-0.36	(0.34)
Ln Mkt Value/employee					0.21	(0.26)
Ln Sales					0.05	(0.14)
Current ratio (current asset/current liability)					-0.51***	(0.14)
Patent Characteristics						
Ln Pat Portfolio/R&D	-0.37	(0.29)	0.00	(0.12)	0.71**	(0.34)
Ln Forward Cites/ Pat Portfolio	0.07	(0.37)	-0.02	(0.17)	-0.24	(0.39)
Ln Backward Cites/ Pat Portfolio	0.51	(0.34)	0.31**	(0.15)	0.32	(0.38)
Originality	-0.01	(0.02)	-0.01*	(0.01)	-0.04**	(0.02)
Generality	0.09	(0.07)	0.01**	(0.01)	0.05**	(0.02)
Number of obs	844		3136		829	
Log pseudo likelihood	-59.0		-248.7		-49.1	
Pseudo R2	0.22		0.10		0.27	
Predicted probability at mean	0.0178		0.0175		0.016	

Note: The dependent variable is a dummy if a firm received an injunction. Robust standard errors are in parentheses. Logit regressions with year dummies, industry dummies, and dummies for "No R&D firms" and "No Patent firms" are not shown.

*Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level

5.2.4 Predicted Probabilities for Various Court Outcomes

Tables 5.14 and 5.15 predict the mean probabilities of various court outcomes across minor and major firms as patentees. The mean probabilities in Table 5.14 are predicted using the base model (included plaintiffs' characteristics and patent characteristics), whereas the mean probabilities in Table 5.15 are predicted using the full model, adding the defendants' characteristics to the base models. The statistics from the Log likelihood ratio tests show that full models are a better fit with the data and therefore the estimated mean probabilities are more reliable in the full models. Both predicted mean probabilities in both the base models and in the full models follow the same pattern among minor and major patentees for all court outcomes, except for settlements. Estimates coming from the base models are overestimated for all court outcomes, except settlements, compared to the full model. The mean predicted probabilities of settlement in the base models are underestimated. The estimates in the full models, reported in Table 5.15, are closer to the frequencies of various court outcomes among all patentees reported in Table 4.7.

Table 5.14: Mean Predicted Probabilities in the Base Models for Various Court Outcomes

Predicted probability at mean using plaintiffs characteristics for all court outcomes by scale						
	All Firms		Small Firms		Large Firms	
Settled or probably settled (%)	45.2	(0.19)	34.7	(0.23)	47.9	(0.19)
Trial (%)	3.3	(0.02)	2.2	(0.02)	3.7	(0.03)
Win for plaintiff (%)	6.6	(0.05)	4.8	(0.05)	7.1	(0.07)
Injunction (%)	1.7	(0.02)	1.8	(0.04)	1.7	(0.02)

Note: Logit regressions are estimated to find the predicted probability for different court outcomes. Robust standard errors are in parentheses.

Minor patentees are less likely to go to trial— about 2.1 percentage points less likely at mean than are major patentees. My results show that minor patentees are significantly more likely to settle a dispute than major patentees. The settlement probability is almost 11 percent less likely when a plaintiff is a major patentee. Major patentees are more likely to settle at an early stage of litigation to take advantage of cross-licensing via settlement and to avoid litigation costs.

My estimates in Table 5.14, using the base models, provide evidence that minor patentees are less likely to win a lawsuit —about 2.3 percentage points less than major patentees. My estimates in Table 5.15 also suggest a similar result. The mean predicted probability of winning at court for large plaintiffs is 4.2% which is about one percent higher than the predicted probability for all firms (which is 3.3%). This implies that the predicted probability of minor patentees should be less than 3.3%. These findings are consistent with hypothesis 2a.

Similarly, the mean predicted probability of granting an injunction for major patentees is 1.6 percent in the full model, larger than the predicted probability for all

firms receiving a preliminary injunction which is 1.2 percent. This suggests that small patentees are less likely to receive a preliminary injunction, which is consistent with hypothesis 2b.

Table 5.15: Mean Predicted Probabilities in the Full Models for Various Court Outcomes

Predicted probability at mean using plaintiffs & defendants characteristics for all court outcomes by scale						
	All Firms		Small Firms		Large Firms	
Settled or probably settled (%)	57.4	(0.13)	66.8	(0.28)	56.0	(0.14)
Trial (%)	2.3	(0.03)	0.8	(0.04)	2.9	(0.03)
Win for plaintiff (%)	3.3	(0.05)			4.2	(0.06)
Injunction (%)	1.2	(0.03)			1.6	(0.04)
Note: Logit regressions are estimated to find the predicted probability for different court outcomes. Robust standard errors are in parentheses.						

In summary, contrary to my expectations, major patentees are more likely continue their dispute at trial than minor patentees. My results provide evidence that major patentees are more likely pursue a trial because they are confident about their patent validity. This increases patentees' negotiation power against defendants, and therefore they ask for a higher settlement transfer in return of infringement of patents.

Minor patentees are more likely to settle a dispute before trial than major patentees. One explanation is that reaching trial stage in a patent litigation lawsuit is still costly, so minor patentees, particularly those who have lower-quality patents, often prefer to settle before trial because their settlement payoffs are more than their expected payoffs at trial (net litigation costs).

Capital-intensive defendants prefer to settle at an early stage of the litigation process mainly due to litigation costs, a lack of direct R&D investment, a fear of hold up, and having few or no patents. My results indicate that capital-intensive defendants are more likely to lose a lawsuit and be subjected to paying damage awards. This implies that capital-intensive firms invest lesson R&D and are more likely to infringe on other patents, advertently or inadvertently, than a typical R&D-intensive firm.

Finally, my results indicate that win rates and injunction rates will be higher for suits in which the plaintiffs have a higher-quality patent portfolio regardless of the size of patentees. A high number of citations, a low score of originality, and a high score of generality are measures of patent quality which lead to a higher win rate and higher injunction rates for plaintiff firms.

Chapter 6

CONCLUSIONS

There are three main empirical findings in my dissertation. First, I attempt to investigate the role of courts by investigating patent lawsuits filed from 1996 to 2010. I use data on over 40,000 patent lawsuits, and track the court outcomes of these suits at different stages of the litigation process. The focus of my analysis is to understand the outcome of each case, and keep track of various court outcomes across the years. My results indicate that many more patent lawsuits are adjudicated through a summary judgment or at trial which exceed our expectation. About 10.4 percent of the suits are terminated in grants of summary judgment and about 3.3 percent of suits are terminated in a final trial. About 6.3% are terminated in consent judgments and 1.4 percent ended up with judgment by default or judgment by arbitrator or by other final judgment methods. As a consequence, a total of about 21.4 percent of all suits are terminated by a court decision and through a court ruling. However, about three-quarters of patent lawsuits[1] in U.S. federal courts are settled or probably settled.

The average number of days to a termination ruling was 50-60 % higher than settled or probably settled suits. My results provide evidence that the most expensive

[1] About 3.6% of patent lawsuits are dismissed suits which are due to a lack of jurisdiction or want of prosecution.

suits are those that go to trial. The average number of days to terminate during trial is 991 which is almost twice as much as the settled suits.

My results also demonstrate that there are slight fluctuations in some years from 1996 to 2010 in the level of litigation costs across the two types of rulings. However, on average, the duration of summary judgment suits grow by about 3.4% annually and the duration of trial suits grow by about 2% yearly. Suits which go to trial are much more costly than those suits resolved through summary judgment rulings from 1996 to 2010. My results show that expenditures, on average, in patent suits are not extremely high, and patent litigation is largely a settlement mechanism. Consequently, a reform in patent laws is required to prompt settlement of patent disputes.

Secondly, I present a decision model that identifies the incidence and nature of patent lawsuits and various court outcomes involving 11,583 litigant firms between 1996 and 2010. By supplementing patent litigation data with patent data drawn from the United States Patents and Trademark Office, I estimate the probability that firms will be involved in patent lawsuits and various court outcomes. I provide strong evidence that demonstrates that the rapid increase in patent litigation can be explained by increases in firm values for the number of patents per dollar of R&D spending, capital expenditures, total R&D spending, market value, scale, liquidity level, and patent portfolio quality (measured by originality, generality, and citations). Lanjouw and Schankerman (2001b) stated that "the settlement and win rate outcomes are almost completely independent of characteristics of patents and their owners." My results,

conversely, clearly provide strong evidence that the likelihood of patent litigation and various court outcomes are systematically related to heterogeneity of patents and parties involved in a lawsuit.

I find that the influential determinants of cooperative solutions via settlement mechanisms are capital intensity, R&D intensity, scale, liquidity level, patenting rate and the quality of patent portfolio. My results suggest that plaintiffs are willing to settle when they have restricted liquidity whereas defendants are willing to settle when they have liquidity ability. I conclude that a high level of defendant's liquidity and a low level of plaintiff liquidity enhance prompt settlement for both parties.

My findings demonstrate that the dominant factor of probability of being granted an injunction is patent portfolio quality. The likelihood of an injunction is higher for patent portfolios with a high score of generality and a low score of originality. The likelihood of winning and receiving an order of injunctive relief proportionally increases with the patents' portfolio quality. Similar to the injunction results, plaintiff win rates increase with the quality of the patent portfolio. Both litigants' characteristics and patent characteristics are the dominant factors driving the likelihood of a win at trial for the plaintiffs. There are two reasons that explain why plaintiffs win at trial and may receive damage awards: (1) plaintiff's capability to better handle litigation costs than defendants, and (2) having higher-quality patents portfolio enables plaintiffs to better defend against infringed patents.

My findings demonstrate that the important factor of the probability of going to trial court is the litigant's scale. Major patentees impose a greater stake to small defendants by refusing to settle prior to trial. Larger plaintiffs look for winning opportunities at trial and receive damage awards or ask for a higher settlement transfer during the trial process.

I find that about 40 percent of filed suits in the pharmaceuticals/drugs industries receive preliminary injunctions, and 25 percent of filed suits continue their disputes in trial court. My results indicate that a litigant's R&D spending tends to be the strongest determinant of litigation in the pharmaceutical industries. Patents in the pharmaceuticals/drugs industries are fairly easily replicated, and this suggests that more aggressive patent reform is required in these industries. The strongest determinant of filing a patent litigation in the computer and software industries is the current ratio. My findings suggest that some plaintiffs target financially secure defendants (with high cash flow and liquidity) to negotiate for a higher settlement transfer at each stages of the litigation process or damage awards at trial. This should be a concern for patent legislator to protect targeted defendants.

Finally, I generated the selection model, for the first time in the context of patent litigation suits, that provide strong prediction that settlement rates, trial rates, plaintiff win rates, and injunction rates would vary as a function of the identity (characteristics) of the litigants, and the identity of the plaintiffs together with their patent characteristics would bear a stronger relationship with various court outcomes

than the identity of the defendants. I implemented the model empirically by assuming that minor patentees vary more in their litigiousness (inverse of litigation cost) than do major patentees. My findings demonstrate that plaintiffs with greater dispersion in the distribution of their litigation cost (minor patentees) tend to settle prior to trial unless they have high patents portfolio quality. Minor patentees are relatively more likely to settle (less likely continue to trial) to take advantage of cross-licensing and to avoid high litigation costs at trial. Conversely, patentees with lower dispersion in the distribution of their litigation cost (major patentees) will be willing to continue at trial in which they have a higher probability of winning a lawsuit, and a greater likelihood of being granted an order of injunctive relief.

I also conclude that suits filed by pools of potential plaintiffs with greater dispersion in the distribution of their litigation costs (minor patentees) will have a lower trial rate, a lower plaintiff win rate and a lower rate of granted injunctions than major patentees. My results indicate that win rates and injunction rates will be higher for suits in which the plaintiffs have higher-quality patent portfolios regardless of the size of patentees. These rates proportionally increase with patent portfolio quality. My empirical analysis yielded results that are consistent with the implications of the selection model.

My empirical evidence is consistent with the view that potential infringed patents are selected for litigation based on the litigiousness of the potential plaintiffs, and this selection process affects a pattern of various court outcomes. It would be

arguable to see how this selection process would affect various court outcomes across industry groups. For example, firms in chemicals, drugs, and pharmaceuticals industries have greater uncertainty due to the fact that patents in those industries are easily and cheaply replicated with little investment. How would the selection process change various court outcomes to mitigate this uncertainty? Finally, I use the litigants as the unit of analysis rather than infringed patents. Using infringed patents as a unit of analysis provide us with a better understanding of the suit-selection process, and consequently, of various court outcomes.

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Appendix

A DISPOSITION CODES

A.1 Case Disposition Codes

Table A.1: Case Disposition Codes*

"**DISPOSITON:**

Suits Transferred or Remanded

0: transfer to another district
1: remanded to state court
10: multi district litigation transfer
11: remanded to U.S. Agency

Dismissals

2: want of prosecution
3: lack of jurisdiction
12: voluntarily
13: settled
14: other

JUDGMENT ON:

4: default
5: consent
6: motion before trial
7: jury verdict
8: directed verdict
9: court trial
15: award of arbitrator
16: stayed pending bankruptcy
17: other
18: statistical closing
19: appeal affirmed (magistrate judge)
20: appeal denied (magistrate judge)

NATURE OF JUDGMENT: (only applies to disposition involving a judgment)

0: no monetary award
1: monetary award only
2: monetary award and other
3: injunction
4: forfeiture/foreclosure/condemnation, etc.
5: costs only
6: costs and attorney fees"

***** Contents of this table were taken from Kesan and Ball (2006)

A.2 Key to Case Disposition Codes

Table A.2: Key to Case Disposition Codes*

"**Lack of Jurisdiction:** Case was dismissed because the court found it did not have jurisdiction; usually personal jurisdiction, especially in declaratory judgment suits;
Dismissal due to Want of Prosecution: Explicitly identified in disposition;
Default Judgments: Explicitly identified in disposition;
Identified Settlements: Case was identified as settled in the dataset. All suits where a reference to some form of judgment was found in the docket were reviewed, and those in which liability was resolved through some form of judgment other than a consent judgment were re-classified in a category referring to the appropriate form of judgment;
Consent judgments: Explicitly identified in the disposition. Not associated with any other form of judgment;
Voluntary Dismissals: Explicitly identified in the data set without reference to a settlement. If a voluntary dismissal occurred before the complaint was answered, it is classified as a non-merit disposition. Voluntary dismissals occurring after the complaint was answered were considered probable settlements. Voluntary dismissals with prejudice were also viewed as probable settlements regardless of whether the complaint was answered;
Summary Judgment: Case terminated with a summary judgment. Not applied to suits in which there was an interim summary judgment that did not totally decide final liability;
Judgment on Jury Trial: Liability decided through a jury verdict. If a final judgment was also issued, still classified as jury trial;
Judgment on Bench Trial: Liability decided through a bench trial; and
Judgment as a Matter of Law: Jury verdict, but change in ruling by a directed verdict."

***** Contents of this table were taken from Kesan and Ball (2006)

B SAMPLE MEAN CHARACTERISTICS

B.1 Sample Mean Characteristics for Identified Plaintiffs

Table B.1: Sample Mean Characteristics for Identified Plaintiffs

Sample Characteristics			
	All Firms	Small Firms	Large Firms
Plaintiff Characteristics			
Capital expenditures ($MM)	511.7	25.6	647.7
R&D ($MM)	818.7	36.4	1037.6
Market value ($MM)	23954.8	429.6	30535.4
Sales ($MM)	8176.0	229.8	10398.8
Plaintiff employment (per thousands)	27.967	0.166	35.744
Current ratio (current asset/current liability)	2.8	5.0	2.2
Patent Characteristics			
Patent portfolio size per year	76.4	8.9	95.3
Aggregate forward citations per year	409.7	54.7	509.0
Aggregate backward citations per year	922.9	188.0	1128.5
Aggregate originality per year	37.0	4.8	46.0
Aggregate generality per year	19.4	2.5	24.1

This table similar to Table 3.1 shows means statistics for variables estimated for firm-year using only identified plaintiffs including non-litigants sample. All mean statistics have similar patterns with means statistics in Table 3.1.

B.2 Sample Mean Characteristics for Identified Litigants

The following table shows the mean of several variables estimated for firm-years using identified samples and non-litigant samples. The first three columns indicate all firm-years observations for plaintiffs. Plaintiff employment size, total asset size, and R&D spending are much larger than the non-litigants sample. Large and R&D intensive firms, on average, are more involved in patent dispute than other firms. The last three columns show all firm-years 'observations for defendants, who spend about the same on R&D as plaintiffs do. Alleged infringers are also larger than plaintiffs in terms of employment size, total asset size, and market value of equity. Both defendants and plaintiffs tend to have a relatively larger current ratio than non-litigants sample, and both almost have the same degree of leverage. The means of the profit margin for plaintiffs and the mean of return on equity for defendants are both almost five times greater than their non-litigant samples.

Table B.2: Sample Mean Characteristics for Identified Litigants

Mean						
	Plaintiffs Sample			**Defendants Sample**		
	All	**litigants**	**Non-litigants**	**All**	**litigants**	**Non-litigants**
Market Value (Millions)	12114.1	19853.6	2116	15054.1	25566.2	3151.7
R&D (Millions)	477.53	783.12	82.76	447.31	739.43	116.56
Leverage	0.35	0.26	0.47	0.24	0.27	0.20
Current ratio	3.33	2.82	3.99	3.23	2.76	3.78
Total Asset (Millions)	6877.01	10922.50	1650.90	7997.41	13045.97	2281.11
Employee (Thousands)	16.36	24.22	6.22	26.01	42.95	6.82
Profit Margin	-2.73	-0.83	-4.67			
Return on Equity				-5.44	-1.90	-8.94

C THE CONDITIONAL MEAN OF THE COST DISTRIBUTION

The derivative of the conditional mean of the cost distribution with the respect to σ is:

$$\frac{\partial \mathrm{E}(\,\mathrm{C}_p \left| C_p < C_p^* \right.)}{\partial \sigma} \;=\; \mathrm{E}\,(\mathrm{Z}\,|\mathrm{Z} < \mathrm{Z}^*) \;- \frac{\partial \mathrm{E}\,(\mathrm{Z}\,|\mathrm{Z} < \mathrm{Z}^*)}{\partial \mathrm{Z}^*} \mathrm{Z}^* \qquad \text{(A. 4.1)}$$

The first term $\mathrm{E}\,(\mathrm{Z}\,|\mathrm{Z} < \mathrm{Z}^*)$ is zero negative because the unconditional expectation of Z is zero. The first part of second term $([\partial \mathrm{E}\,(\mathrm{Z}\,|\mathrm{Z} < \mathrm{Z}^*)]/\,\partial \mathrm{Z}^*)$ is positive because increasing the right truncation point of a distribution increases the conditional mean. The sign of second term is still dependent on sign of Z^*. If the threshold cost value is greater or equal than the mean of the unconditional cost distribution ($C_p^* \geq \mu$), then Z^* is positive. However, it seems unreasonable to assume all firms have a taste for litigiousness. Therefore, the rate of the filing of lawsuits is low relative to the pool of patent infringement. It seems irrational that the threshold plaintiff's litigation cost value is greater than the unconditional mean. If the cost distribution were symmetric, then a threshold above the mean would yield a suit rate greater than fifty percent, which is not in accordance with existing evidence.

The more reasonable view is where $C_p^* < \mu$, so that $\mathrm{Z}^*$is negative. If the cost distribution is symmetric, the threshold below mean yields a suit rate of less than fifty percent which makes more sense with the existing evidence. The effect of scale

parameter on the conditional mean is still ambiguous. Both terms in the above equation are negative so the sign of their difference is unknown.

There is a restriction on the distribution of Z that is sufficient for the needed result. An increase in σ reduces the conditional mean of litigation costs, and this restriction satisfies many common distributions. If the above equation were rewritten by adding and subtracting Z*, it would look like this:

$$\frac{\partial \mathrm{E}(\,\mathrm{C}_p \left| C_p < C_p^* \right.)}{\partial \sigma} \;=\; [\mathrm{E}\,(\mathrm{Z}\,|\mathrm{Z} < \mathrm{Z}^*) - \mathrm{Z}^*] \;-$$

$$[\,[\partial \mathrm{E}\,(\mathrm{Z}\,|\mathrm{Z} < \mathrm{Z}^*)/\,\partial \mathrm{Z}^*)] - \;1]\,\mathrm{Z}^* \qquad (\mathrm{A}.4.2)$$

A distribution of some random variable X is log-concave if the density function satisfies the following condition:

$$f(\lambda x_1 \;+\; (1+\lambda)x_2\,) \;\geq\; [f(x_1\,)]^{\lambda}[f(x_2\,)]^{\lambda-1} \qquad (A.4.3)$$

Based on Heckman and Honore's (1990) findings, the logarithm of the density function must be a concave function in order to show the following:

$$0 \leq [\partial \mathrm{E}\,(\mathrm{Z}\,|\mathrm{Z} < \mathrm{Z}^*)]/\,\partial \mathrm{Z}^* \leq\; 1 \qquad (\mathrm{A}.4.4)$$

In equation 3.7, the first term in brackets is negative by construction. As long as the density function of Z is log-concave, it is sufficient to argue the second term is negative. Since Z^* is negative when $C_p^* < \mu$, log concavity of the distribution of Z is sufficient for demonstrating following conclusion:

$$[\partial \mathrm{E}\,\left(C_p \left| C_p < C_p^*\right.\right)]/\,\partial \sigma \leq\; 0 \qquad (\mathrm{A}.4.5)$$

D PERMISSION FOR USING RESTRICTED DATA FROM THE FEDERAL COURT CASE: INTEGRATED DATA BASE FROM 1970 THROUGH 2009

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October 9, 2012

Professor William Latham
Department of Economics
University of Delaware
316B Purnell Hall
Newark, DE 19711

Dear Professor Latham:

Thank you for your order for restricted data from the Federal Court Cases: Integrated Data Base from 1970 through 2009. Accordingly, we are enclosing cds containing restricted use data and documentation for these studies, with the exception of the 2007 study. We do not have a restricted version for that study. The zip files on the cds are password protected; I will email the password.

As you know, conditions for receiving these data include your agreement not to redistribute them, to protect the confidentiality of the data respondents, and to use the data for research purposes only. A copy of the fully executed Restricted Data Use Agreement is enclosed. This agreement is in effect until the completion of your research project or October 3, 2014, whichever comes first.

If you have further questions or if we can be of additional assistance, please let us know.

Sincerely,

Arun Mathur
User Support

Enclosure