DO "FUZZY" SOFTWARE PATENT BOUNDARIES EXPLAIN HIGH CLAIM CONSTRUCTION REVERSAL RATES?

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ABSTRACT

Bessen and Meurer (2008) theorize that a breakdown in notice of patent boundaries caused the patent litigation surge of the 1990s. They argue a prime source of this breakdown was the proliferation of software patents with particularly uncertain scope. In this paper I seek evidence that software patent scope is more uncertain by extending the empirical literature on claim construction reversal rates to determine whether the Federal Circuit has been more likely to find error in district court construction of software patents. Not only do I find that it has, I find that over the last decade software patents account for over one third of the difference between the Federal Circuit's high claim construction reversal rate and its lower average reversal rate on all other patent issues. These results are cause for optimism in that in general the application of existing claim construction law is more predictable that has been feared. However, this optimism does not extend to software claim construction, which is highly unpredictable.

1. INTRODUCTION

Patent litigation is so expensive that it has been described as the “sport of kings”. (Kline 2004) Legal fees for one case can range from $500,000 through summary judgment to over $4 million through trial. (Bessen & Meurer 2008) These direct costs, however, may be dwarfed by the social cost of patent litigation in reducing incentives for producers to bring innovative products to market. (Bessen et al. 2011) Supporting this possibility, Bessen and Meurer (2008) found that after the number of patent lawsuits doubled during the 1990s litigation costs became greater than patent-associated profits in most industries.

Given the potential impact of the recent litigation surge on innovation, it is vital we understand why it happened. Bessen and Meurer (2008) argue the principle cause was the breakdown in notice of what patents protect. The substantial literature chronicling the Federal Circuit Court of Appeals’ (“Federal Circuit”) high rate of reversing district court claim construction supports the idea of inadequate notice. Further, it suggests owners and producers cannot be certain of the legal scope of any patent until the Federal Circuit has spoken. Bessen and Meurer (2008), however, argue that by their nature software patents have particularly “fuzzy” boundaries and thus more uncertain scope. Accordingly, they argue the proliferation of software patents was responsible for a large share of the 1990s patent litigation surge.

Bessen and Meurer’s (2008) account is appealing to the many critics of software patents. However, there is little evidence supporting the proposition that software patents possess less certain scope. I seek to remedy this gap in the patent law and economics literature by determining whether the Federal Circuit has been more likely to disagree with district court software patent claim construction, taking into account selection effects.

There is widespread agreement within the claim construction literature that the high Federal Circuit reversal rate reflects unpredictability or uncertainty as to how the courts will ultimately define the boundaries of litigated patents. However, scholars differ on whether the source of this uncertainty is bad claim construction law, poor application of the law or merely the natural result of parties selecting the most uncertain cases for appeal. Regardless of the source, claim construction appeals speak directly to patent scope because patent claims define the legal boundaries of patent protection.

I seek evidence that software patents possess more uncertain scope using the population of 908 Federal Circuit opinions between January 1, 2002 and May 15, 2012 that reviewed U.S. district court claim construction. In these decisions, the Federal Circuit reviewed construction of claims of 1273 utility patents asserted in 885 lawsuits. In most of my analysis, I measure scope uncertainty as the rate the Federal Circuit found any error in lower court claim construction. To compare my results with Federal Circuit reversal rates on other issues, I also calculate the rate at which software and non-software patent appeals are reversed, vacated or remanded because of claim construction error.

Like Allison et al. (2009), I define software patents broadly to include all patents that claim novel data processing. However, I check the robustness of my results using Bessen’s (2011) narrower definition based on U.S. Patent and Trademark Office (“PTO”) technology classes. Regardless of the definition, I find the Federal Circuit is significantly more likely to disagree with district court claim construction when the litigated patent claims software. Using Allison et al.’s (2009) definition, the Federal Circuit found claim construction error in 45.1 percent of the opinions involving software patents and 28.9 percent of the opinions involving non-software patents.

I determine that selection and adjudicator biases are unlikely to explain my basic results through multivariate analysis controlling for relevant patent, party, and litigation characteristics. In particular, I find the Federal Circuit is more likely to find software claim construction error regardless of which party won in district court and regardless of whether the owner was a non-practicing entity (“NPE”). My analysis thus strongly supports the inference that the Federal Circuit is more likely to disagree with lower court software patent claim construction because the legal boundaries of software claims are less certain.

My most surprising result is how much of the elevated claim construction reversal rate is due to software patents. Claim construction errors led the Federal Circuit to reverse, vacate or remand in 29 percent of the appeals I reviewed. That rate is 40 percent for software and 25 percent for non-software appeals. In contrast, the average reversal rate across all other patent issues and separately for all federal civil appeals is 18 percent. (Sichelman 2010) Thus, software claim construction errors account for over one third the difference between the claim construction reversal rate and the reversal rate on other issues.

Moreover, if we compare the non-software reversal rate to the 25 percent rate in other complex appeals, software patents may be responsible for the entire difference. (Sichelman 2010) Either way, my results suggest that in general the application of claim construction law is not unusually unpredictable. Rather, claim construction unpredictability is largely a software patent phenomenon and if we wish to decrease it we must specifically reform software patent law.

In Part 2 of this paper I explain why software patents theoretically possess more uncertain scope and why, if they do, Federal Circuit reversal rates may reveal this uncertainty. Part 3 describes my data and method of analysis. Part 4 reports my results and analyzes alternative explanations to my finding that the Federal Circuit has been much more likely to disagree with district court software claim construction. Part 5 summarizes policy implications and concludes the paper.

2. SOFTWARE PATENTS, UNCERTAINTY AND FEDERAL CIRUCIT REVERSAL RATES

2.1. "The Name of the Game Is The Claim"

In the United States, inventors apply for patents from the PTO. The heart of a patent application is one or more "claims" which are written descriptions of what ideas the patent will protect. (Wagner & Petherbridge 2004) Patent claims define the metes and bounds of an inventor's property rights. (Moore 2001) Because claims define the scope of patent rights, they are the natural focus of any investigation into the relative certainty of different types of patent boundaries.

The basic requirements for the ideas expressed in the claims to be legally patentable are that they cover patentable subject matter, are new and useful, and non-obvious. (35 USC §§ 101, 103) If the inventor demonstrates to the PTO that the claims meet these requirements, the PTO grants the patent. Thus, as an initial matter, the claims determine whether the inventor receives a patent at all. As Judge Giles Rich famously noted, in patent law "the name of the game is the claim."[1]

Patents provide their owners with the right to exclude others from making, using, offering to sell, or selling the invention described in the claims. (35 USC § 271) Parties violating the owner's exclusive

[1] In full, Judge Rich stated: "The U.S. is strictly an examination country and the main purpose of the examination, to which every application is subjected, is to try to make sure that what each claim defines is patentable. To coin a phrase, *the name of the game is the claim*." (Rich 1990)

rights, as described in the claims, are liable for infringement and may be sued for damages and injunctive relief. (35 USC § 271) Defining the meaning and scope of the claim terms is the first step in any patent infringement analysis.[2]

How are claims defined in litigation? Since *Markman v. Westview Instruments, Inc.*[3], district court judges alone and not juries have defined claim language, typically prior to the summary judgment stage during what is known as a *Markman* hearing. The Federal Circuit, which has had exclusive jurisdiction over patent appeals since it was created in 1982, reviews a district court's claim construction *de novo*.[4] The Federal Circuit almost never accepts interlocutory appeals of claim construction.[5] Rather, a final appealable decision on a motion for a preliminary injunction, or judgment on infringement and/or validity, must be entered before the Federal Circuit will review district court claim construction.[6]

Because the first step to both infringement and validity analysis is claim construction[7], the party that wins its preferred constructions is often the party that wins the lawsuit. Thus claim construction is often hotly contested. In reviewing prior studies of the Federal Circuit's claim construction reversal rate, we will see that claims are also frequently difficult for judges to define. But first I explain why the scope of software patents may be especially uncertain.

2.2. Why Software Patents May Possess "Fuzzier" Property Boundaries

In "Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk", Bessen and Meurer (2008) theorize that the main cause of the patent litigation surge of the 1990s was a breakdown in

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[2] See *Dow Chem. Co. v. United States*, 226 F.3d 1334, 1338 (Fed. Cir. 2000); *KCJ Corp. v. Kinetic Concepts, Inc.*, 223 F.3d 1351, 1355 (Fed. Cir. 2000).

[3] 52 F.3d 967, 970-71 (Fed. Cir. 1995) (en banc), aff'd, 517 U.S. 370 (1996).

[4] *Cybor Corp. v. FAS Techs., Inc.*, 138 F.3d 1448, 1456, (Fed. Cir. 1998) (en banc).

[5] Put simply, interlocutory appeals are appeals before final judgment. *See* Singh (2005) for a description of the rules governing interlocutory appeals in patent litigation. In constructing his exhaustive database of all Federal Circuit cases reviewing claim construction from *Markman* through mid-2007, Schwartz (2008) located a single instance in which the Federal Circuit granted an interlocutory appeal on claim construction: *Regents of Univ. of Cal. V. Dako N. Am.*, 477 F.3d 1335 (Fed. Cir. 2007).

[6] However, "litigants have developed the practice of using preliminary injunctions and summary judgment motions to obtain early claim construction rules and possible pre-trial Federal Circuit review of the district court's claim construction." (Lane & Pepe 2001) In my research for this paper I find the most common route to obtaining early claim construction review is for owners who lose their claim construction arguments to stipulate to a judgment of non-infringement after the *Markman* hearing.

[7] *Cybor Corp. v. FAS Techs., Inc.*, 138 F.3d 1448, 1456, (Fed. Cir. 1998) (en banc).

notice of what particular patents protect. Further, they argue a key source of the breakdown and thus the increase in litigation was the proliferation of software patents which claim abstract ideas. (Bessen & Meurer 2008) With abstract ideas it is more difficult to “relate the words that describe patent boundaries to actual technologies.” (Bessen & Meurer 2008)

Bessen and Meurer (2008) devote an entire chapter of their book to explaining why they believe software patents possess more uncertain scope. The essence of their argument is captured in their discussion of the widely litigated U.S. Patent No. 4,528,643, asserted by owner E-Data against hundreds of technology companies, small businesses and individuals (the “E-Data patent”). Bessen and Meurer (2008) explain that the actual invention that led to the E-Data patent was a shopping mall kiosk or retail store vending machine “for producing digital music tapes or other digital reproductions.”

On appeal, the E-Data patent litigants disputed five separate claim terms, including “point of sale location”—industry jargon for “the location within a retail store where items are checked out and transactions take place.” (Bessen & Meurer 2008) Focusing on the retail industry’s use of this term, the district judge construed it as excluding transactions in private homes. The Federal Circuit disagreed and interpreted it more broadly to cover at-home transactions, such that the patent legally covered a wide range of e-commerce applications that had not been invented until after the E-Data patent was granted.

The Federal Circuit agreed with the district court’s narrow construction of “material object”, another of the disputed claim terms. This was construed as a functional limitation that required infringing technology “to produce a digital reproduction in something separate from the computer itself”, for example a compact disk or a cassette tape. (Bessen and Meurer 2008) Bessen and Meurer (2008) argue, however, that even this narrow interpretation covered “a wide range of activities far beyond the original invention, activities that merely shared a functional similarity to the original invention.”

Claim limitations such as “point of sale location” and “material object” are abstract because they are disassociated from specific embodiments. While abstract terms and vague functional language are sometimes present in non-software patents, Bessen and Meurer (2008) argue software is “particularly susceptible to the use of abstract terms because many of the standard terms of art are themselves abstract

ideas that are meant to apply to a wide variety of possible applications; that is, software is itself an abstract technology." Thus, Bessen and Meurer (2008) argue that the distinguishing feature of abstract patents is that they claim technologies unknown to the inventor.

The E-Data litigation suggests that owners and potential infringers will be uncertain how wide a variety of applications a software patent with abstract terms legally covers until the patent's claims are construed by the courts. In contrast, the scope of patents with more precise structural language, such as those claiming specific chemical compounds, will be better known by disputing parties prior to litigation. (Bessen and Meurer 2008) Put another way, a chemical compound is a uniquely identified structure and over time the terms used to describe it change slowly or not at all. Conversely, the meaning of many common software patent terms change quickly as new applications are rapidly developed.

Bessen and Meurer (2008) argue that if they are correct that software patent scope tends to be more uncertain, then software patent disputes will be much less likely to settle. Accordingly, since the Federal Circuit made it easier to obtain software patents during the 1990s, they are plausibly responsible for a disproportionate share of the litigation surge of that decade. I now review the literature on Federal Circuit claim construction reversal rates and explain how scholars investigating this issue see reversal as evidence of uncertain patent scope.

2.3. Evidence of Uncertain Patent Scope in Prior Literature on Claim Construction Reversal Rates

Many law and economics scholars have documented and attempted to explain the apparent high rate at which the Federal Circuit has disagreed with district court claim construction since *Markman*.[8] Moore (2001, 2005) and Schwartz (2008, 2010) provide the most accurate measures of claim construction reversal rates because their studies alone analyze Rule 36 summary affirmances.[9]

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[8] Gruner (2010) summarizes the findings of earlier empirical papers on this topic, including Bender (2001), Chu (2001), Moore (2001), Zidel (2003), Moore (2005), Saunders (2007), Schwartz (2008). More recent empirical papers include Schwartz (2010) and Anderson and Menell's (2012) forthcoming paper entitled "From *de novo* Review to Informal Deference: An Empirical Examination of Patent Claim Construction".

[9] Moore (2005) explains that "[w]hen the Federal Circuit resolves an appeal, it can issue a precedential opinion, a non-precedential opinion, or a summary affirmance. Precedential opinions . . . are published and create citable precedent on the issues of law to which they pertain. Non-precedential opinions are law of the case in which they are issued, but do not create citable precedent. [Fed. Cir. R. 47.6(b).] . . . The court may also resolve a case by a

Moore (2005) found that from *Markman* through the end of 2003, the Federal Circuit held at least one term was wrongly construed in 37.5 percent of the cases for which district court claim construction was appealed. These errors required the Federal Circuit to reverse, vacate or remand the district court's judgment in 29.7 percent of these appeals. Schwartz (2008), in analyzing decisions from *Markman* through June 30, 2007, found similar percentages of 38.2 and 29.7 for these measures of disagreement with lower court claim construction. The "background" reversal rate for all federal civil litigation and also for all patent issues other than claim construction was 18 percent during the same time period. (Sichelman 2010) Thus, the claim construction reversal rate appears abnormally high.

Most scholars studying this issue argue high claim construction reversal rates introduce an undesirable level of unpredictability or uncertainty into patent disputes.[10] These scholars typically focus on deficiencies in the law of claim construction, or at least Federal Circuit guidance on how district judges should apply it, as the cause of this heightened uncertainty. A few, however, argue the high claim construction reversal rate does not reflect legal failure but rather the selection of disputes involving patents with the most uncertain scope for appeal. (Gruner 2010) If the majority is correct, then uncertainty in claim construction affects the ability of all lawyers, and by extension all patent owners and alleged infringers, "to predict outcomes in legal disputes." (Mullally 2010) But even if Gruner (2010) is correct, the high rate of claim construction appeal along with a high rate of claim construction reversal is strong evidence that the parties in many adjudicated patent disputes remain uncertain of patent scope.

Rule 36 summary affirmance. [Fed. Cir. R. 36.] This is an affirmance of the district court without opinion. These affirmances leave intact and affirm the judgment of the district court . . . A case is not summarily affirmed because it is unimportant and should not be considered. It is summarily affirmed because the district court got it right, and there is no new law that needs to be explained, defined, clarified or established. There are no summary reversals. Whenever the Federal Circuit reverses, it issues an opinion explaining how and why the district court was wrong."

[10] See, e.g., Lee and Krug (1999) at 67 ("Although, according to the Federal Circuit and the Supreme Court, *Markman* should have ushered in greater uniformity, predictability, and certainty in patent litigation, many believe that the holding has had the opposite effect. This is largely because Federal Circuit review of claim interpretation is *de novo*."); Moore (2001) at 38 ("The 33% reversal rate of district court claim constructions … infuses the patent system with a high degree of uncertainty until the Federal Circuit rules on claim construction."); Schwartz (2008) at 225-27 (describing some aspects of unpredictability); Petherbridge (2008) at 221("[A]s claim construction becomes at once more unpredictable and more prominently involved in other areas of the patent law, the court's treatment of other areas of law might, by association, also become more unpredictable."). But see, Jeffery A. Lefstin, Claim Construction, Appeal, and the Predictability of Interpretive Regimes, 61 U. Miami L. Rev. 1033 (2007) (questioning scholarly emphasis on predictability in claim construction).

Among those scholars who believe claim construction law has been deficient, Moore (2005) pointed to the fact that the claim construction reversal rate had not decreased eight years after *Markman* as evidence that the Federal Circuit had not provided sufficient guidance on claim construction. "There have not evolved any clear canons of claim construction to aid district court judges, and in fact the Federal Circuit judges seem to disagree among themselves regarding the tools available for claim construction." (Moore 2005) Wagner and Petherbridge (2004) analyzed Moore's (2005) idea of disagreement among Federal Circuit judges. They concluded the Federal Circuit was "sharply divided between two basic methodological approaches to claim construction, each of which leads to distinct results." The effect of this divide has been panel dependency in Federal Circuit claim construction.

Petherbridge (2009) investigated whether claim construction became more predictable after the victory of one of these two methodological approaches in *Phillips v. AWH Corp*.[11] He concluded that despite *Phillips*, too much claim construction unpredictability remains. Sichelman (2010) argued that the lingering uncertainty in claim construction results from "competing canons of [claim] interpretation" and the legal assumption that "a person of ordinary skill in the art can usually unambiguously interpret a disputed claim term".

In contrast with this line of reasoning, Gruner (2010) argues that the high claim construction reversal rates are not the result of deficiencies in claim construction law or Federal Circuit guidance but rather the natural result of selection effects, the principal one being that losing parties select disputes involving patents with the most uncertain scope for claim construction appeal. Most who focus on legal failure admit that selection effects probably play a role but point to the fact that appeals are relatively inexpensive and the greater frequency of reversal compared with other issues as evidence that there is something fundamentally wrong with claim construction law or its application.[12]

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[11] 425 F.3d 1303 (Fed. Cir. 2005) (en banc).

[12] In challenging Gruner's (2010) hypothesis, Sichelman (2010) admits that "even if Gruner's selection bias theory does not fully account for seemingly high claim construction reversal rates, it does account for some of the problem. Whatever one's view of settlement, a decent share of cases arriving at the Federal Circuit are likely to present difficult legal and factual issues. In other words, even if cost constraints cause many uncertain cases to settle, those

Despite these differences in opinion as to the principle cause of the claim construction reversal rate, all of these scholars essentially agree that Federal Circuit disagreement with district courts reveals uncertainty in the legal boundaries of the litigated patents at issue in those appeals. This suggests Federal Circuit claim construction decisions may be utilized to test the theory that software patents have more uncertain scope. I now explain how selection theory also supports this approach. Along the way I report existing evidence from litigation statistics that supports the idea that the scope of software claims is particularly uncertain.

2.4. Theoretical Evidence for Software Scope Uncertainty within a Selection Model

Empirical analysis of patent litigation trial and outcome rates can provide evidence for or against Bessen and Meurer’s (2008) argument that software patents possess more uncertain scope. However, there are many factors including judicial bias and selection effects unrelated to uncertainty that also theoretically influence these litigation statistics. Selection effects refer to the process of parties choosing disputes for adjudication instead of settlement. Priest and Klein (1984) created the first formal model of this process which predicts both the rate at which disputes will be tried and the plaintiff’s win rate at trial. (Siegelman and Waldfogel 1999) In the basic model these rates depend on the: 1) Decision standard; 2) Amount of uncertainty; and 3) Degree of stake asymmetry. (Siegelman and Waldfogel 1999) Later models predict other factors influence win rates, including asymmetric information, rent seeking, and differences in risk aversion. (Cooter and Rubinfeld 1989)

These factors theoretically influence plaintiff win rates and confound inferences about the population of potential disputes from the set of disputes selected for adjudication. However, selection models also make specific predictions about the direction in which these factors will influence trial rates and outcomes. It must be noted that some scholars are critical of the use of selection theory to explain legal disputes in the real world. (See, e.g., Eisenberg 1990; and Schwartz 2010) However these skeptics typically focus on the fact we rarely observe plaintiffs winning 50 percent of cases as Priest and Klein’s

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cases with the most certain outcomes are likely to settle at much higher rates than those with uncertain outcomes. Thus, the Federal Circuit hears a skewed set of cases relative to those filed, which increases reversal rates.”

(1984) basic model predicts. I doubt this would have surprised even Priest and Klein, as that basic model assumes idealized conditions where damages are stipulated and the parties possess equal stakes, symmetric information, risk neutrality and lack strategic behavior. (Moore 2000)

Assuming none of these conditions apply, I do not utilize selection theory to predict specific trial or plaintiff win rates but rather the relative rates for types of disputes theoretically characterized by more or less of a particular selection effect.[13] For example, if we believe non-practicing entity ("NPE") patent disputes possess more asymmetric stakes, then we can determine whether the trial rate is higher and the plaintiff win rate is lower, as the model I adopt predicts. If they are, it does not conclusively demonstrate NPE lawsuits are more asymmetric as judicial bias or other selection effects might explain the results. However, in controlling for other characteristics of the disputes that likely capture these other factors, we may conclude stake asymmetry is the most likely explanation. Using this analytical approach, in this paper I adopt Waldfogel's (1995) selection model as applied to patent disputes by Marco (2004).[14] I now discuss existing evidence in support of Bessen and Meurer's (2008) argument in terms of that model.

In the context of litigation, there are several dispute resolution decisions theoretically subject to selection effects. These include: 1) Whether to litigate or settle pre-litigation; 2) Whether to litigate through adjudication or settle pre-trial; and 3) Whether to appeal after adjudication or accept the lower court's judgment. (Gruner 2010) As to the first decision, Marco (2004) predicts that disputes with more uncertain outcomes are more likely to be litigated. Bessen and Meurer (2008) report that software patents are in fact more likely to be litigated. However, Marco's model also predicts that disputes with lower litigation costs, higher case value and greater differences in stakes are also more likely to lead to litigation. To my knowledge no one has empirically eliminated these alternate explanations.

As to the second decision, Marco's (2004) model predicts that with increased case quality uncertainty, we will observe a higher percentage of litigated patent disputes being adjudicated and an

[13] Other legal scholars successfully utilizing this approach include Siegelman and Waldfogel (1999), Lederman (1999) and Marco (2004).

[14] Marco (2004, pp. 7-12) provides a complete description of how different selection effects, including uncertainty, theoretically influence the rate at which different types of patent disputes are litigated and the rate at which different types of litigated disputes win adjudication.

owner win rate on adjudication approaching the hypothetical population win rate we would observe if all software patent disputes were adjudicated. No one has directly tested either of these predictions.

In earlier work, I hypothesize that disputes involving patents asserted in many lawsuits will tend to be higher quality. (Miller 2012) Case quality is another selection variable in Marco’s (2004) model. Supporting my hypothesis, I found owners who assert their patents in more lawsuits are more likely to win validity and infringement judgments. However, I found repeat software patent plaintiffs are not more or less likely than software owners who assert their patents in fewer lawsuits to win on infringement. I argue this is most likely explained within Marco’s (2004) model by more uncertain software patent scope.

Concerning the third decision—whether to appeal—the selection model again predicts both the relative rate at which different types of litigated patent disputes are appealed and the rate at which different appeals are reversed. While Marco’s (2004) model does not specifically address appeals, Priest and Klein (1984) argued selection effects should have the same impact in trials and appeals. Adapting Marco’s (2004) model to appeals, if software patents possess more uncertain scope, then losing parties in software patent disputes should be more likely to appeal claim construction. Bessen and Meurer (2008) report that software patents are in fact more likely to be involved in claim construction appeals. This supports, but again does not prove, the proposition that software patents possess more uncertain scope.

Finally, no one has analyzed the relative reversal rate of software claim construction. Within Marco’s (2004) model, the appellant win rate on appeal—equal to the reversal rate—for disputes involving patents with more uncertain scope should approach the population win rate for that type of patent. What is the relative population reversal rate for types of patents with more uncertain scope? Since reversal clearly indicates disagreement between the trial and appellate judges, common sense strongly suggests that it should be “high”. This conclusion is reinforced by the consensus among claim construction scholars that “high” reversal rates reflect uncertainty. I thus hypothesize that if software claims possess more uncertain scope, then the Federal Circuit should more frequently reverse district court software claim construction.

3. STUDY DESIGN

3.1. Data

I created a data set including all published and unpublished Federal Circuit claim construction decisions from January 1, 2002 to May 15, 2012.[15] My data includes all Federal Circuit opinions during that time period in which the appellate court reviewed at least one district court claim construction. It includes all precedential and non-precedential opinions, as well as all Rule 36 decisions that lack a written opinion.[16] Like Schwartz (2008, 2010) and Moore (2001, 2005) before him, in each opinion I determined whether the Federal Circuit explicitly rejected at least part of the district court's claim construction and also whether claim construction error required the Federal Circuit to reverse, vacate or remand the district court judgment that led to the appeal. I also determined this information for each patent where the construction of multiple patents was challenged on appeal.

Overall, my data set includes 908 different Federal Circuit opinions in which it reviewed construction of claims of 1333 utility patents. My data includes multiple appeals for a minority of patents and lawsuits. Thus, it includes Federal Circuit review of 1273 distinct patents asserted in 885 distinct lawsuits. Across the entire population, the Federal Circuit found claim construction error in 33.2 percent of the opinions. These errors required the court to reverse, vacate or remand in 28.9 percent of opinions.

Coding data from court documents is an inexact science, using even the best methods. However, comparing the "reversal" rates I observe with those reported by Schwartz (2008, 2010) suggests that I have consistently replicated his method. Schwartz (2008) reports the Federal Circuit found at least one claim construction error in 48.7 and 22.4 percent of opinions in 2003 and 2006 respectively. In my set, these rates are 47.8 and 23.1 percent. Further, Schwartz (2010) reports that his data set includes 318 opinions dated between *Phillips* in July 2005 and the end of 2008. 28.0 percent of these opinions reversed, vacated, or remanded the district court judgment due to claim construction error. During the

[15] In doing so, I replicated the methodology of Schwartz (2008, 2010). For a complete explanation of Schwartz' method of selection and coding, see Schwartz (2008) at 269-74.

[16] See note 9 for Moore's (2005) explanation of Rule 36 summary affirmances.

same time frame, my set includes 323 opinions, with the Federal Circuit reversing, vacating or remanding 27.2% of the time. These comparisons show that with minimal variation, my data set is consistent with the opinions selected and coded by Schwartz (2008, 2010).

3.2. Method of Analysis

To test my hypothesis that the Federal Circuit will more frequently find error in lower court software claim construction because software patents possess more uncertain scope, I first determined which opinions review software patent claim construction. Next, to test whether selection effects other than uncertainty or adjudicator bias likely account for the significant difference I observe, I gather many characteristics of the patents, the parties and the adjudication that may be significant predictors of the likelihood that the Federal Circuit will find claim construction error. I define and explain the relevance of these characteristics as I use them in reporting the results of my analysis. I obtain all of this data from the PTO's online patent database, LexisNexis, and the Stanford IP Litigation Clearinghouse ("IPLC").

Turning to the key independent variable of my study, I determine whether each patent whose claim construction was reviewed covered software. I define software two ways. First, following Allison et al. (2009), I broadly define patents as software if "at least one claim element in the patent consists of data processing—the actual manipulation of data—regardless of whether the code carrying out that data processing is on a magnetic storage medium or embedded in a chip." I thus reviewed the claims of every patent in my sample for data processing and hand coded those that include at least one such claim as software. It is important to note that while "at least one claim element" suggests over inclusion, all of the patents with one data processing claim possess many such claims.

To test the robustness of my findings from the first definition of software, I utilize the more objective definition of Bessen (2011). For that study, he defines as software those patents assigned particular PTO technology classes that either include data processing in the classification title[17] or are "reliant on software and in which software companies obtain patents."[18] 135 of the 908 Federal Circuit

[17] PTO classes 700-707 and 715-717.

[18] PTO classes 341, 345, 370, 375, 380, 381, 382, 726 and 902.

opinions in my sample reviewed software claim construction under either definition, 102 more under only Allison et al.'s (2009) definition, 4 under only Bessen's (2011) definition, and 667 under neither.[19] While coding with Allison et al.'s (2009) definition is more subjective,[20] my review of the patents I study supports their contention that many patents that claim software are assigned non-software PTO classes.[21]

4. RESULTS AND DISCUSSION

Now that I have described my data and basic method of analysis, I report my results. In Section 4.1, I provide a comparison of software and non-software patent reversal rates. In Section 4.2, I discuss the impact of patent, party and adjudication characteristics on my basic result that the Federal Circuit is far more likely to disagree with lower court claim construction when the patent protects software.

4.1. Software and Non-Software Claim Construction Reversal Rates

In Table 1 I report the percentage ("error rate") and number of appellate decisions in my data set in which the Federal Circuit found any claim construction error, for both software and non-software patents.[22] Further, I separately report these differences using both Allison et al. (2009) and Bessen's (2011) definition of software. Regardless of the definition, the Federal Circuit has been significantly more likely to find software claim construction error to a 99-percent confidence level. Further, there is only a 1.3 percent difference in the error rate across the two definitions. This demonstrates that there has been an elevated software claim construction error rate whether software is broadly or narrowly defined.

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[19] It is important to note that in every multiple patent appeal all patents fall within the same software categories.

[20] To verify the reliability of my coding, I provided patent law professor Ted Sichelman (University of San Diego School of Law) with a list of 25 patents I coded software according to Allison et al.'s (2009) definition and 25 I coded as non-software. I randomly selected these patents from my data set. After reviewing the claims of all 50 patents, Professor Sichelman agreed that my coding in each case conformed to Allison et al.'s (2009) definition.

[21] Examples of software patents in my set not assigned one of Bessen's (2011) PTO classifications include U.S. Patent Nos.: 4,877,404 claiming a "Graphical interactive software system"; 4,895,163 claiming a "System for body impedance data acquisition" including algorithmic "prediction formulas"; 5,561,707 claiming a "Telephonic-interface statistical analysis system"; 5,788,573 claiming an "Electronic game method and apparatus with hierarchy of simulated wheels"; 6,117,073 claiming an "integrated emergency medical transportation database system" with "software modules"; 6,535,743 claiming a "System and method for providing directions using a communication network"; 6,973,481 claiming a "System and method for creating and managing forwarding email address"; 7,006,608 claiming a "Software algorithm and method of enabling message presentation during a telephone ringing signal period"; 7,075,673 claiming an "Information processing methodology"; and 7,343,414 claiming a "System and method for distributing media assets to user devices and managing user rights of the media assets".

[22] In the bivariate comparisons reported in Tables 1 through 3 I include the results of a Chi-square test of the null that there is no difference in the error rate of software and non-software patent claim construction.

Table 1

RATE THAT FEDERAL CIRCUIT FINDS ERROR IN SOFTWARE AND NON-SOFTWARE CLAIM CONSTRUCTION

	Non-Software	Software	Chi square
Allison et al. (2009) Software:			
# of Appeals	671	237	$\chi^2(1) = 20.832$,
# of Appeals w/ Error	194	107	p = 0.000**
Error Rate	28.9%	45.1%	
Bessen (2011) Software:			
# of Appeals	769	139	$\chi^2(1) = 8.535$,
# of Appeals w/ Error	240	61	p = 0.003**
Error Rate	31.2%	43.9%	

NOTE.—Significant differences in software and non-software rates designated: $^{+}$ $p < .10$. * $p < .05$. ** $p < .01$.

More surprising than the fact that the Federal Circuit is more likely to find software claim construction error is the magnitude of the difference. Using Allison et al.'s (2009) definition, the Federal Circuit has been over 50 percent more likely to find software claim construction error.[23] The magnitude of this difference extends to a comparison of the rate at which claim construction error required the Federal Circuit to reverse, vacate or remand district court judgments. I calculate reversal rates of 39.7 and 25.0 percent for software and non-software patents respectively (*p* value = 0.00). Referencing the overall reversal rate of 28.9 percent, reported above, I find software patents are responsible for 36 percent of the difference between the Federal Circuit's reversal rate due to claim construction error and its 18 percent reversal rate on all other patent issues. (Sichelman 2010)

4.2. The Impact of Patent, Party and Adjudication Characteristics

My basic results support the theory that software patents possess more uncertain scope and that this technology-specific uncertainty explains much of the "abnormal" claim construction reversal rate. However, at this stage many will rightfully object that the elevated software claim construction error rate may be due to selection effects other than uncertainty or to judicial biases. I now test the likelihood that uncertain scope is the explanation by controlling for characteristics that theoretically represent these alternative explanations. I begin with bivariate analysis of two of the most interesting dispute

[23] For the remainder of my analysis I utilize Allison et al.'s (2009) definition of software patents.

characteristics. I then turn to multivariate analysis of the likelihood of software claim construction error controlling for a large group of patent, party and adjudication characteristics.

Is the Elevated Software Error Rate Explained by Who Won at the District Court?

Besides uncertainty, two of the most plausible explanations for my results are asymmetric stakes and adjudicator bias. However, if either explains my basic results, we should observe high claim reversal on appeals from software owner wins or losses but not both. To test the plausibility that stakes or judicial bias explains my results, I reviewed both appellate and district court documents and determined if the owner or the alleged infringer(s) appealed claim construction. In Table 2, I report that the Federal Circuit has been more likely to find software claim construction error regardless of who won at the district court.

While who won below does not explain my basic results, there is an effect. The highest error rate is on appeals from owner wins in software cases with the lowest on appeals from owner wins in non-software cases. In software cases, the Federal Circuit is more likely to find error in appeals from owner wins (60.0%) than from owner losses (41.2%). In contrast, in non-software cases it is more likely to find error in appeals from owner losses (32.0%) than owner wins (21.2%). These results plausibly reflect differences in stake asymmetry between software and non-software disputes or some bias for or against software owners. However, the error rate remains significantly larger in software appeals regardless of who won below. This result strongly supports the theory that software claim scope is more uncertain.

Table 2

IMPACT OF WINNING PARTY IN DISTRICT COURT ON CLAIM CONSTRUCTION ERROR RATE

	Appeal from Owner Win		Appeal from Owner Loss	
	Non-Software	Software	Non-Software	Software
Total # of Appeals	193	50	478	187
# of Appeals w/ Error	41	30	153	77
Error Rate	21.2%	60.0%	32.0%	41.2%
Chi square	$\chi^2(1) = 28.843$, p = 0.000**		$\chi^2(1) = 4.993$, p = 0.025*	

NOTE.—Significant differences in software and non-software rates designated: $^{+}$ $p < .10$. * $p < .05$. ** $p < .01$.

Does NPE Ownership Explain the Elevated Software Claim Construction Error Rate?

Criticism of software patents often goes hand in hand with criticism of NPEs. To test whether my basic results are better explained by who owned the patents, I determine whether the patents in each appeal were owned by NPEs or product firms. NPEs include all owners except those I identify as selling products or services. Most NPEs in my data set are individual inventors or patent licensing firms, but a few are universities and other research institutions.

In Table 3, I report the difference in the claim construction error rate for software and non-software patents for both NPE and product firm owned patents. The difference is statistically significant for both NPE and product firm patents and for both the Federal Circuit is more likely to find software claim construction error. Thus, whether the patent is asserted by an NPE does not explain my results.

Table 3

IMPACT OF PATENT OWNER TYPE ON CLAIM CONSTRUCTION ERROR RATE

	Product Firm Owner		Non-Practicing Entity	
	Non-Software	Software	Non-Software	Software
Total # of Appeals	534	133	137	104
# of Appeals w/ Error	163	68	31	39
Error Rate	30.5%	51.1%	22.6%	37.5%
Chi square	$\chi^2(1) = 19.967$, p = 0.000**		$\chi^2(1) = 6.345$, p = 0.012*	

NOTE.—Significant differences in software and non-software rates designated: $^{+}$ $p < .10$. * $p < .05$. ** $p < .01$.

However, as in comparing who won below, there is an effect. I observe that the Federal Circuit finds less error in NPE appeals regardless of whether they assert software or non-software patents. This is at odds with the idea, explained by Bessen and Meurer (2005) and others, that NPEs strategically assert patents of more uncertain scope. The fact that NPEs were more likely than product firm owners to lose their construction arguments at the district court suggests an explanation for my result.

NPEs won their preferred construction at the district court in 47 of the 241 (19.5 percent) appellate opinions in my set that involve NPE-asserted patents. In contrast, 29.4 percent of appeals involving product firm owners were from product firm wins. The difference is plausibly explained by litigation being relatively less costly for NPEs because they have no products of their own and thus

cannot be countersued for patent infringement. (Chien 2009) Further, patent enforcement is the core business of many NPEs so that they are probably less averse to litigation than other patent owners. (Chien 2009) With lower litigation costs, Marco's (2004) model predicts that NPEs will appeal more often and thus appeal weaker judgments with the result I observe that they are more likely to lose on appeal.

Multivariate Analysis Controlling for Other Patent, Party and Adjudication Characteristics

I now test the robustness of my basic results with probit regression. With software as my primary independent variable, I control for many patent, party and adjudicator characteristics that theoretically capture adjudication bias or correlate with selection effects other than uncertainty. I report nine different specifications and report their results in Tables 4 and 5.[24]

Patent Characteristics. In Specification 1, I test whether my basic results hold controlling for patent characteristics.[25] Several of the characteristics I utilize theoretically proxy patent value or legal quality, two important selection effects included in Marco's (2004) model. These include the number of claims, number of citations received, and the number of lawsuits in which a patent has been asserted. Lerner (2007) explains how the first two characteristics proxy patent value or quality. In Miller (2012), I explain the connection of the third to legal quality. Following Marco (2004), I measure citations received as the average number of citations per claim per year since a patent was granted. I obtain this and the number of claims from the PTO's online database and the number of lawsuits asserted from the IPLC.

I also obtain the year each patent was granted, theorizing that older patents may possess less complex claims, and the application duration, which I define as the number of months between the date each patent's parent application was filed with the PTO and its grant date. Patents with longer application duration may be more complex and thus more likely to have their claims reversed on appeal. Referencing Table 4, none of these characteristics is significant in Specification 1. However, the Federal Circuit is significantly more likely to find error when the patent claims software.

[24] I report the marginal effects for each independent variable using Stata's *dprobit* command.

[25] For all specifications that include these characteristics, the population includes the 1333 distinct patent-appellate opinion pairs I identify. In these specifications robust standard errors are clustered by distinct appellate opinion.

Party Characteristics. When controlling for party characteristics alone in Specification 2, I find the Federal Circuit remains significantly more likely to find software claim construction error. The party characteristics I include are whether or not the patent owner is an NPE and whether the patent owner or alleged infringer is a large product firm. I define large firms as those publicly traded or on Forbes' list of the largest private companies.[26] These characteristics theoretically capture differences in stake asymmetry, case value or litigation costs and all three are significant to a 90 percent confidence level.

Additionally, in Specification 2 I control for whether the owner or alleged infringer(s) are foreign, joining Lanjouw and Schankerman (2001) in theorizing that these will have higher litigation costs.[27] However, neither foreign indicator is significant. Finally, I control for the number of alleged infringers ("# Defendants in Suit") and the number of patents asserted in the underlying lawsuit. I theorize both of these variables capture the complexity of the dispute or case value. The first may also capture differences in stakes. The Federal Circuit is significantly more likely to find error when there are more alleged infringers in the lawsuit, suggesting that it does capture some selection effect.

District Court Adjudication Characteristics. In Specification 3, I determine whether software remains significant when controlling for characteristics of the district court adjudication. First, from the IPLC and LexisNexis I determined whether the appeal was from the grant or denial of a preliminary injunction, from the grant of summary judgment, after jury or bench trial, or from the grant or denial of judgment as a matter of law ("JMOL"). These are all plausible predictors of the likelihood the Federal Circuit finds claim construction error because they involve different decision standards and because the Federal Circuit may defer to some of these decisions more than others. Using bench trial as my omitted category, I find the Federal Circuit is significantly more likely to find claim construction error in appeals from summary judgment, jury trial and JMOL. However, only JMOL is significant to a 95 percent level.

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

[27] I code my foreign alleged infringer indicator "1" only if all alleged infringers are foreign entities. In contrast, I code my large alleged infringer indicator "1" if at least one alleged infringer is a public or large private firm.

Table 4

PROBIT ESTIMATION OF LIKELIHOOD OF FEDERAL CIRCUIT FINDING CLAIM CONSTRUCTION ERROR

	1	2	3	4	9
Software	.15** (.03)	.20** (.04)	.17** (.04)	.19** (.03)	.19** (.03)
Patent Characteristics:					
Application Duration	-.0013 (.0008)			-.0013 (.0008)	-.0011 (.0007)
Grant Year	.0005 (.0023)			.0003 (.0025)	.005^{+} (.003)
# Claims	.0005 (.0004)			.0006^{+} (.0004)	.0007^{+} (.0004)
Ave Citations	.019 (.023)			.025 (.023)	.023 (.024)
# Suits Asserted	-.004 (.002)			-.004* (.002)	-.004^{+} (.002)
Party Characteristics:					
NPE Owner		-.069 (.042)		-.004 (.036)	.008 (.038)
Lrg. Product Owner		.068^{+} (.041)		.079* (.034)	.076* (.035)
Foreign Owner		-.013 (.048)		.030 (.041)	.083^{+} (.045)
Foreign Defendant		-.000 (.045)		.011 (.036)	.018 (.036)
Large Defendant		-.064^{+} (.038)		-.058^{+} (.032)	-.048 (.033)
# Defendants in Suit		.005* (.002)		.004** (.001)	.003* (.001)
# Patents Asserted		-.001 (.005)		-.013** (.005)	-.008 (.005)
Dt Court Judgment:					
Prelim. Injunction			.10 (.12)	.15 (.11)	.16 (.12)
On Summary Jgmt.			.11^{+} (.06)	.12* (.05)	.17** (.05)
On Jury Trial			.15* (.08)	.13* (.07)	.21** (.07)
On JMOL			.23* (.11)	.31** (.09)	.32** (.10)
CACD			.10 (.07)	.06 (.06)	.09 (.06)
CAND			-.10^{+} (.06)	-.11* (.04)	-.10* (.04)
CASD			-.08 (.11)	-.06 (.08)	-.08 (.08)
CO			-.00 (.13)	-.03 (.11)	-.03 (.11)
DE			-.08 (.06)	-.09^{+} (.04)	-.11* (.04)
FLSD			-.19^{+} (.08)	-.18^{+} (.07)	-.16 (.08)
ILND			-.04 (.07)	-.05 (.05)	-.05 (.06)
MA			-.07 (.08)	-.12^{+} (.05)	-.15* (.05)
MIED			-.02 (.09)	-.05 (.08)	-.05 (.08)
MN			.18 (.12)	-.03 (.07)	-.01 (.08)
NJ			-.06 (.09)	-.06 (.07)	-.09 (.06)
NYSD			-.04 (.07)	-.06 (.05)	-.06 (.05)
OHND			-.12 (.11)	-.16 (.07)	-.07 (.10)
PAED			-.25^{+} (.07)	-.24* (.05)	-.24* (.05)
TXED			-.12^{+} (.06)	-.10^{+} (.05)	-.08 (.05)
TXND			-.02 (.12)	.04 (.10)	.03 (.10)
TXSD			-.20* (.07)	-.20** (.05)	-.18* (.06)
VAED			.03 (.12)	.005 (.079)	-.06 (.07)
WAWD			-.07 (.11)	-.05 (.10)	-.08 (.10)
WIWD			-.15^{+} (.07)	-.08 (.07)	.01 (.08)
Log-likelihood	-791	-559	-548	-756	-708
Observations	1333	908	908	1333	1333

NOTE.—Population of 908 Federal Circuit decisions between January 1, 2002 and May 15, 2012 that included explicit review of claim construction. These comprise 1333 distinct patent-appeal pairs. Marginal effects reported with discrete change of dummy variables from 0 to 1. Robust standard errors included in parenthesis.

$^{+}$ $p < .10$. * $p < .05$. ** $p < .01$.

Additionally, I create indicator variables for the twenty district courts with the most appellate decisions in my data set. Theoretically, the Federal Circuit may be biased against some districts more likely to hear software disputes, or some districts like the much criticized Eastern District of Texas (“TXED”) may be more likely to receive low quality disputes. I find that the Federal Circuit is less likely to find claim construction error to at least a 90 percent confidence level in appeals from six of these districts—the Northern (“CAND”) and Southern Districts of California (“CASD”), the Southern Districts of Florida (“FLSD”) and Texas (“TXSD”), the Eastern District of Pennsylvania (“PAED”) and, perhaps surprisingly, TXED. Despite the significance of many of these district court adjudication characteristics, software retains its significance in Specification 3.

Combined Patent, Party and District Court Characteristics. In Specification 4, I combine the controls in the first three specifications. The coefficient on Software remains as significant and is larger than almost all prior specifications. While the NPE and CASD indicators lose their significance, several characteristics gain significance. First, the number of claims becomes a significant predictor of error suggesting it captures dispute complexity, value or perhaps simply more opportunity for the Federal Circuit to find error. Likewise, the number of lawsuits asserted becomes significant to a 90 percent level. This may support my hypothesis in Miller (2012) that patents asserted in more lawsuits possess higher legal quality. Finally, the number of patents asserted becomes a significant negative predictor.

Appellate Adjudication Characteristics. Switching to Table 5, in Specifications 5 through 8 I test the effect of characteristics of the appellate decision on my basic results. For Specification 5, I create a count variable ranging from 1 for January 2002 to 125 for May 2012. This indicates the month within the range of my data set that the appeal was decided. Appeal Month tests the theory of Moore (2001) and others that the district courts should be getting better at claim construction over time as they obtain more instruction from the Federal Circuit. My results in Table 5 are consistent with this belief and show the Federal Circuit has found less claim construction error over time. While interesting, this fact does not explain the elevated software claim construction error rate.

In Specification 6, my basic result that the Federal Circuit is more likely to find software claim construction error remains. Here, I substitute Appeal Month for a variable indicating whether the appeal was decided after *Phillips*.[28] Consistent with Petherbridge (2009) and Anderson and Menell (2012), I find that the Federal Circuit has been less likely to find claim construction error after this opinion.

I also include a variable indicating whether a judge dissented on claim construction in each opinion. This likely captures whether an appeal was particularly difficult to decide. Its high positive significance supports the connection between my dependent variable and claim scope uncertainty.

In Specification 7, I create indicator variables for the author of each Federal Circuit claim construction opinion that had one.[29] I utilize Judge Gajarsa as my omitted author as his opinions find claim construction error nearest the average rate. Judges Reyna, Friedman and Wallach were dropped from this regression because they either authored no opinions or affirmed or reversed claim construction in every one of their opinions. Judges Dyk, Linn and Rader were significantly more likely to find claim construction error. However, controlling for opinion authorship does not explain my basic result.

Neither does the makeup of the panel deciding each appeal. In Specification 8, I include variables for each Federal Circuit judge indicating whether they agreed with the panel's claim construction opinion. While Federal Circuit judges appear to be randomly selected (Petherbridge 2009), Wagner and Petherbridge (2004) demonstrate that Federal Circuit claim construction opinions have been panel dependent. My results support to this conclusion, with the Federal Circuit less likely to find claim construction error when Judges Bryson, Mayer, Newman or Prost agree with the majority.

Combined Patent, Party, District and Appellate Characteristics. In Specification 9, reported in both Table 4 and 5, I combine the controls in Specification 4, 6 and 8 and thus include a full battery of patent, party and adjudication characteristics. In this specification, as in all previous, software is significant to a 99 percent level. Further, the marginal effect is larger than most prior specifications, with the Federal Circuit 19% more likely to find claim construction error when the patent covers software.

[28] See note 11, *supra*, and accompanying text.

[29] All Rule 36 opinions are per curiam, as are a minority of written opinions within my data set.

Table 5

PROBIT ESTIMATION OF LIKELIHOOD OF FEDERAL CIRCUIT FINDING CLAIM CONSTRUCTION ERROR

	5	6	7	8	9
Software	.18** (.04)	.19** (.04)	.20** (.04)	.17** (.04)	.19** (.03)
Appeal Characteristic:					
Appeal Month	-.0014** (.0005)				
Phillips		-.11** (.03)			-.17** (.04)
Dissent		.26** (.05)			.19** (.07)
Fed. Circuit Judge:					
Archer			.15 (.17)	-.06 (.08)	-.02 (.08)
Bryson			.02 (.10)	-.08^{+} (.04)	-.06 (.05)
Clevenger			.15 (.11)	.04 (.05)	.02 (.05)
Dyk			.25* (.10)	.07 (.05)	.13* (.05)
Friedman				.05 (.07)	.03 (.07)
Gajarsa			x	x	-.03 (.05)
Linn			.16^{+} (.10)	.01 (.05)	.04 (.05)
Lourie			.08 (.09)	.01 (.04)	.02 (.05)
Mayer			-.13 (.13)	-.15** (.04)	-.06 (.05)
Michel			-.05 (.11)	-.06 (.05)	-.01 (.05)
Moore			.11 (.11)	-.06 (.05)	-.02 (.06)
Newman			-.09 (.12)	-.08^{+} (.04)	-.05 (.05)
O'Malley			.10 (.22)	-.02 (.13)	.00 (.12)
Plager			.00 (.19)	-.04 (.06)	-.03 (.06)
Prost			-.03 (.10)	-.13** (.04)	-.09* (.04)
Rader			.17^{+} (.09)	.004 (.043)	.05 (.05)
Reyna				-.16 (.10)	-.12 (.09)
Schall			.11 (.11)	-.05 (.05)	.01 (.05)
Wallach				-.17 (.17)	-.11 (.17)
Designee			-.14 (.15)	-.08 (.06)	.03 (.07)
Log-likelihood	-562	-548	-452	-546	-708
Observations	908	908	695	908	1333

NOTE.—Population of 908 Federal Circuit decisions between January 1, 2002 and May 15, 2012 that included explicit review of claim construction. These comprise 1333 distinct patent-appeal pairs. Marginal effects reported with discrete change of dummy variables from 0 to 1. Robust standard errors included in parenthesis.

$^{+}$ $p < .10$. * $p < .05$. ** $p < .01$.

Finally, in Appendix Tables A1 and A2 I reproduce my results for Specification 9, using Allison et al.'s definition of software as in Tables 4 and 5 and also using Bessen's (2011) narrower but more objective coding. While the marginal effect of software decreases to 11% using Bessen's definition, the significance and sign remain the same. Thus, my entire analysis supports the conclusion that during the last decade the Federal Circuit has been much more likely to find error in district court software patent claim construction. Furthermore, my multivariate analysis strongly suggests that this fact is explained by greater software patent scope uncertainty and not adjudication biases or other selection effects.

5. IMPLICATIONS AND CONCLUSION

In this paper I analyze the difference in the rate at which the Federal Circuit has disagreed with district court claim construction in cases asserting software and non-software patents. I find that since 2002 the Federal Circuit has been far more likely to find software claim construction error. The failure of other patent, party or adjudication characteristics to account for this result strongly suggests that it is due to software patents possessing more uncertain legal scope than non-software patents.

Prior work finds that software patents are more likely to be litigated, more likely to lose adjudicated lawsuits, and more likely to be subject to a claim construction appeal. I believe these findings combined with my results in this paper provide strong empirical support for the proposition that uncertain software patent scope has been responsible for a significant portion of the increase in patent litigation we have observed since the early 1990s. To clinch the case, future research should analyze earlier data to verify that the rise of software patenting and not Federal Circuit claim construction precedent caused the increase in claim construction reversal after *Markman* that Schwartz (2010) has documented.

My results also show that, excluding software, the application of claim construction law has been more predictable than feared. I find claim construction error led the Federal Circuit to reverse, vacate or remand 39.7 percent of software and 25.0 percent of non-software appeals. The combined reversal rate is 28.9 percent. With an average reversal rate of 18 percent across all other patent issues and across all federal civil appeals (Sichelman 2010), software claim construction errors thus account for over one third the difference between the high claim construction reversal rate and the lower background reversal rate.

Sichelman (2010), however, persuasively argues that claim construction should be compared with other complex legal issues. He reports an analogous reversal rate of 25 percent in bankruptcy appeals. (Sichelman 2010) If there is a similar reversal rate in other complex appeals, software patents may account for the entire “abnormal” component of the claim construction reversal rate. Using either comparison, claim construction law appears to be working quite well for non-software patents.

Again, my results demonstrate that the same cannot be said of software claim construction, which is highly unpredictable. If this unpredictability has generated an inefficient amount of litigation risk, as

seems likely in light of Bessen and Meurer's (2008) research, then policy makers should adopt reforms that make software patent boundaries more certain for owners and technology users prior to litigation. I argue the changes most likely to achieve this goal will clarify and increase the information available to interested parties to estimate software boundaries pre-litigation and to courts construing software claims.

While a thorough investigation of the most cost effective reform is beyond the scope of this paper, I end by introducing two promising proposals. Each has the virtue of improving the information the courts already use to define patent boundaries. In *Phillips*, the Federal Circuit held that claims must be construed by reviewing the "intrinsic evidence", which includes the claim language, specification and prosecution history, which is the record of correspondence between the patent examiner and applicant.[30]

Petherbridge (2006) proposes "positive examination" to remedy the fact that prosecution history adds little information on scope because examination focuses on comparing prior art to proposed claims. Under his plan, examiners would create claim charts listing their interpretation of claim limitations. An applicant could convince the examiner to amend it, but the final chart and related correspondence would become part of the prosecution history. The prosecution history, like all intrinsic evidence, is available to the public. Thus, if this proposal were adopted for software patents, then owners and technology users would have access to a fuller record of the boundaries as conceived by the examiner and applicant.

Alternatively, Burk and Lemley (2005) and Kappos and Strimaitis (2005) propose strengthening the enablement requirement for software patents such that their boundaries are closely limited to what is described in the specification. Currently, the Federal Circuit enforces a lax software patent enablement standard that allows broad functional claims with little technical disclosure in the specification.[31] This generates uncertainty by allowing owners to plausibly claim subject matter beyond that conceived by the inventor. Tightening the standard could make the specification "the single best guide" for determining the meaning of software claims, as the Federal Circuit in *Phillips* held it should be for all patents.[32]

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[30] *Phillips v. AWH Corp*, 415 F.3d 1303, 1314-15, 1317 (Fed. Cir. 2005) (en banc).

[31] See, e.g., *Fonar Corp. v. General Electric Co.*, 107 F.3d 1543, 1549 (Fed. Cir. 1997).

[32] *Id*. at 1315.

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APPENDIX

Table A1

PROBIT ESTIMATION OF LIKELIHOOD OF FEDERAL CIRCUIT FINDING NO CLAIM CONSTRUCTION ERROR

	9 (Allison et al. (2009) Software)	9 (Bessen (2011) Software)
Software	.19** (.03)	.11** (.04)
Patent Characteristics:		
Application Duration	-.0011 (.0007)	-.0010 (.0007)
Grant Year	.005^{+} (.003)	.005^{+} (.003)
# Claims	.0007^{+} (.0004)	.0010* (.0004)
Ave Citations	.023 (.024)	.034 (.024)
# Suits Asserted	-.004^{+} (.002)	-.004^{+} (.002)
Party Characteristics:		
NPE Owner	.008 (.038)	.020 (.038)
Lrg. Product Owner	.076* (.035)	.062^{+} (.036)
Foreign Owner	.083^{+} (.045)	.082^{+} (.046)
Foreign Defendant	.018 (.036)	.011 (.036)
Large Defendant	-.048 (.033)	-.032 (.033)
# Defendants in Suit	.003* (.001)	.004* (.002)
# Patents Asserted	-.008 (.005)	-.007 (.005)
Dt Court Judgment:		
Prelim. Injunction	.16 (.12)	.16 (.11)
On Summary Jgmt.	.17** (.05)	.17** (.05)
On Jury Trial	.21** (.07)	.20** (.07)
On JMOL	.32** (.10)	.32** (.09)
CACD	.09 (.06)	.08 (.06)
CAND	-.10* (.04)	-.09* (.04)
CASD	-.08 (.08)	-.07 (.08)
CO	-.03 (.11)	-.01 (.11)
DE	-.11* (.04)	-.09* (.04)
FLSD	-.16 (.08)	-.16 (.08)
ILND	-.05 (.06)	-.05 (.06)
MA	-.15* (.05)	-.13* (.05)
MIED	-.05 (.08)	-.07 (.07)
MN	-.01 (.08)	-.005 (.078)
NJ	-.09 (.06)	-.10 (.06)
NYSD	-.06 (.05)	-.04 (.06)
OHND	-.07 (.10)	-.10 (.10)
PAED	-.24* (.05)	-.24* (.04)
TXED	-.08 (.05)	-.04 (.06)
TXND	.03 (.10)	.05 (.11)
TXSD	-.18* (.06)	-.17* (.06)
VAED	-.06 (.07)	-.02 (.08)
WAWD	-.08 (.10)	-.06 (.10)
WIWD	.01 (.08)	.01 (.08)
Log-likelihood	-708	-721
Observations	1333	1333

NOTE.—Population of 908 Federal Circuit decisions between January 1, 2002 and May 15, 2012 that included explicit review of claim construction. These comprise 1333 distinct patent-appeal pairs. Marginal effects reported with discrete change of dummy variables from 0 to 1. Robust standard errors included in parenthesis.

$^{+}$ $p < .10$. * $p < .05$. ** $p < .01$.

Table A2

PROBIT ESTIMATION OF LIKELIHOOD OF FEDERAL CIRCUIT FINDING NO CLAIM CONSTRUCTION ERROR

	9 (Allison et al. (2009) Software)	9 (Bessen (2011) Software)
Software	.19** (.03)	.11** (.04)
Appeal Characteristic:		
Appeal Month		
Phillips	-.17** (.04)	-.16** (.04)
Dissent	.19** (.07)	.16** (.07)
Fed. Circuit Judge:		
Archer	-.02 (.08)	-.05 (.07)
Bryson	-.06 (.05)	-.08 (.04)
Clevenger	.02 (.05)	.01 (.05)
Dyk	.13* (.05)	.11* (.05)
Friedman	.03 (.07)	.004 (.071)
Gajarsa	-.03 (.05)	-.05 (.04)
Linn	.04 (.05)	.02 (.05)
Lourie	.02 (.05)	.004 (.046)
Mayer	-.06 (.05)	-.07 (.05)
Michel	-.01 (.05)	-.03 (.05)
Moore	-.02 (.06)	-.03 (.06)
Newman	-.05 (.05)	-.05 (.05)
O'Malley	.00 (.12)	.01 (.12)
Plager	-.03 (.06)	-.04 (.06)
Prost	-.09* (.04)	-.11* (.04)
Rader	.05 (.05)	.03 (.05)
Reyna	-.12 (.09)	-.14 (.08)
Schall	.01 (.05)	.00 (.05)
Wallach	-.11 (.17)	-.09 (.18)
Designee	.03 (.07)	.002 (.064)
Log-likelihood	-708	-721
Observations	1333	1333

NOTE.—Population of 908 Federal Circuit decisions between January 1, 2002 and May 15, 2012 that included explicit review of claim construction. These comprise 1333 distinct patent-appeal pairs. Marginal effects reported with discrete change of dummy variables from 0 to 1. Robust standard errors included in parenthesis.

$^{+}$ $p < .10$. * $p < .05$. ** $p < .01$.