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Explaining the "unpredictable": An empirical analysis of U.S. patent infringement awards

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ABSTRACT

Patent infringement awards are commonly thought to be unpredictable, which raises concerns that patents can lead to unjust enrichment and impede the progress of innovation. We investigate the unpredictability of patent damages by conducting a large-scale econometric analysis of award values. We begin by analyzing the outcomes of 340 cases decided in US federal courts between 1995 and 2008 in which infringement was found and damages were awarded. Our data include the amount awarded, along with information about the litigants, case specifics and economic value of the patents-at-issue. Using these data, we construct an econometric model that explains over 75% of the variation in awards. We further conduct in-depth analysis of the key factors affecting award value, *via* targeted regressions involving selected variables. We find a high degree of significance between award value and *ex ante*-identifiable factors collectively, and we also identify significant relationships with accepted indicators of patent value. Our findings demonstrate that infringement awards are not systematically unpredictable and, moreover, highlight the critical elements that can be expected to result in larger or smaller awards.

1. Introduction

Patent infringement awards are commonly thought to be unpredictable. Patents are often characterized as "volatile" assets with the potential to give rise to blockbuster awards and "bet-the-company" liabilities.[2] This sentiment is also echoed in the most recent Federal Trade Commission report on the patent system, which highlights a "lottery ticket mentality" toward patent litigation outcomes.[3] Congressional reports have also accepted patent damages to be "untethered" from economic underpinnings.[4] This accepted belief of unpredictability contributes to a fear of patent litigation in many sectors.

Moreover, the specter of unpredictability casts doubt on the legitimacy of the patent grant itself. Fundamentally, the incentives to innovate that patents are intended to provide are predicated on a patent holder's ability to predictably defend his or her patent. If the rewards conferred by the patent system are unpredictable, then their attendant incentives fail to function and the system itself is suspect. Accordingly, discovering whether or not infringement

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[1] The views expressed are solely those of the authors and do not reflect the views of others, including PricewaterhouseCoopers LLP, Northwestern University, Harvard University, Microsoft Corporation, Skadden, Arps, Slate, Meagher & Flom LLP (or its attorneys or clients), or any of their affiliates.

[2] As a recent New York Times article observed, "Patents are a volatile, spot market . . . a market that is more like art than stocks or oil," *With Smartphone Deals, Patents Become a New Asset Class*, New York Times, September 24, 2012 (quoting Ronald S. Laurie, managing director of Inflexion Point Strategy).

[3] Federal Trade Commission, *The Evolving IP Marketplace, Aligning Patent Notice and Remedies with Competition* (March 2011), *Available at* www.ftc.gov/os/2011/03/110307patentreport.

[4] Senate Report on the patent reform Act of 2009, S. Rep. 111-18, at 8 (May 12, 2009) ("damage awards . . . are too often excessive and untethered from the harm that compensatory damages are intended to measure") pdf [hereinafter "2009 Senate Report"].

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awards are predictable is crucial to both validating and critically analyzing the patent system and its real-world costs and benefits.

This study provides a direct empirical assessment of the unpredictability of patent damages. We analyze the behavior of patent infringement awards over a 14-year period. In our study, we systematically catalog the size of damage awards and explore factors that contribute to the observed dollar amounts, using economic value as a benchmark.[5] We find that *ex ante*-observable factors of the litigants, case specifics and patents-at-issue explain over 75% of the variation of resulting infringement awards. We further study the significant factors influencing award value and show that many are also factors known to influence rates of patent litigation.

Our data comprise 340 patent infringement damage awards granted by a judge or jury in United States district courts from 1995 to 2008. These data were derived from a proprietary dataset owned by PricewaterhouseCoopers ("PwC"), which PwC licensed to us for use in this study. The PwC dataset, which has been an important resource for patent policy and reform efforts,[6] contains over 1300 final patent decisions in US district courts from 1995 to 2008. We supplement the PwC dataset by reviewing the original case records for data regarding the damages theories used, patents asserted and procedural disposition, as well as venue and party characteristics. We then code these data into over 120 variables describing various aspects of the cases and awards. We perform several regression analyses on the data, seeking in the first stage to demonstrate that the data can explain a large portion of the variation in award size and in the second stage studying significant regressors to identify key drivers of damage amounts. The result is a comprehensive empirical evaluation of the nature and characteristics of patent infringement damage awards in US district courts during this 14 year period.[7]

Our key findings include the following. The distribution of award levels is skewed, with a small number of very high dollar valued awards relative to the bulk of the distribution. Specifically, the largest eight awards comprised over 47% of the aggregate awards amount over the time period studied. The explanatory variables we include do a very good job at explaining the size of infringement damages. Our econometric model accounts for over 75% of variation across the dataset. Our analysis of significant factors influencing patent awards finds that the following tend to be associated with *higher* award values: more patents per case; more mature patents; patents with more claims and patents with more forward citations; cases decided by juries; and more complex cases (as measured by longer times to trial).

Section 2 addresses relevant prior scholarship and legal background. Section 3 outlines the research methodology employed in this article and presents descriptive statistics about the dataset. Section 4 provides the results of the empirical analysis. Finally, Section 5 concludes by discussing policy implications and questions for future study.

Also, to avoid confusion, we emphasize that this paper does not make (or attempt to make) out-of-sample predictions of patent value. The data represents only a small fraction of patents issued, licensed or enforced in a given year. We discuss certain other limitations in the data in Section 3.1. We do explore in the theoretical discussion some of the implications of what we observe about infringement awards, and query possible links to underlying "patent value". Yet, we are also interested in the extent to which observed court-awarded value might be fundamentally different than agreed-upon value (*e.g.*, in licenses or patent transfers), marketplace value (*e.g.*, in commercialized inventions), capital value (*e.g.*, as represented in the patent-holder's equity value), *etc.*

2. Background

The principal justification for granting a patent is to encourage the creation and disclosure of inventions *via* the reward of temporary exclusive rights over their practice.[8] This incentive structure is so core to our society that it is codified in the U.S. Constitution (Article I, Section 8). The holder of a patent may exclude others from making, using, selling, offering for sale or importing the invention defined by its claims.[9] In turn, one held to be infringing patent rights may be liable for damages and/or an injunction against the accused activity. As exemplified by the recent Apple-Samsung verdict, patents can be tremendously valuable. Their value gives rise to significant economic effects and implications for the progress of technological advancement.[10]

Two necessary components of the patent system's incentive structure are the credible threat of litigation and availability of remedies. Section 284 of the Patent Act of 1952 provides a right to obtain damages for patent infringement. Pursuant to Section 284, a successful claimant is entitled to receive "damages adequate to compensate for the infringement, but in no event less than a reasonable royalty for the use made of the invention by the infringer."[11] A losing defendant may also be enjoined against engaging in the infringing activity, most commonly when the plaintiff and defendant are direct competitors.[12]

Yet, as ever-greater numbers of patents are granted and more infringement suits are filed, patent litigation and patent remedies have increasingly become an object of concern.[13] One core fear is that patent litigation (and the threat thereof) frustrates the innovation process. This fear is exacerbated by the complexity of patent cases and the perceived unpredictability of resulting outcomes. If litigation outcomes are random, the risk to the accused infringer of proceeding with a suit, and *ex ante* engaging in activity that could be claimed to be infringing, intensifies. Accordingly, over-deterrence could occur, and productive innovation efforts could be forestalled.

The fear of unpredictability has also pervaded policy debates and fueled patent reform efforts in the legislative and other arenas. Before passage of the America Invents Act, the leading proposal on damages reform sought to bolster the judge's role as the "gatekeeper" of evidence,[14] with the explicit aim of preventing jury

[5] We refer to the economic literature on patent valuation to build a statistical model based on factors that have been shown to affect the economic value of patents.

[6] See, e.g., 2009 Senate Report, *supra* note 3, at 9 n.40 (*citing* 2007 PwC Study).

[7] Our analysis may miss some patent infringement damage awards from cases where relevant information was not reported (though we believe the impact on our conclusions to be minimal). Further, as the dataset only contains awards in US district courts before appeal, we cannot make definitive statements about the effect of the higher courts' decisions on final patent damage awards. Caveats regarding our findings are discussed further in subsequent sections.

[8] The Supreme Court has articulated the reward theory underpinnings of the patent grant as follows: The patent laws promote [the "progress of science and the useful arts"] by offering a right of exclusion for a limited period as an incentive to inventors to risk the often enormous costs in terms of time, research, and development. The productive effort thereby fostered will have a positive effect on society through the introduction of new products and processes of manufacture into the economy, and the emanations by way of increased employment and better lives for our citizens. *Kewanee Oil Co. v. Bicron Corp.*, 416 U.S. 470, 480–81 (1974).

[9] 35 U.S.C. § 271. In addition to other requirements, there is often a domestic territorial restriction on infringing conduct.

[10] On August 24, 2012, a jury awarded Apple $1.05 billion in damages in its patent infringement suit against Samsung. See *Apple Wins Big in Patent Case*, Wall Street Journal, August 25, 2012.

[11] § 284.

[12] *eBay, Inc. v. MercExchange, L.L.C.*, 547 U.S. 388, 391 (2006).

[13] For example, a recent New York Times article discussed the perceived "destructive use of software patents" at length. *The Patent, Used as a Sword*, New York Times, October 7, 2012.

[14] The "gatekeeper" proposal would have augmented the judge's role as evidentiary gatekeeper by requiring the judge to exclude all methodologies and factors used in calculating infringement damages that are not supported by "sufficient"

errors and random verdicts "untethered" from real-world value.[15] Additionally, several recent cases decided by the Federal Circuit and certain lower courts have focused on restricting evidentiary rules and limiting fact-finder discretion.[16] The trend appears directed at improving the clarity and corresponding predictability of damage awards.

Despite the concerns over unpredictability, there is little available empirical analysis. In fact, the extent to which patent infringement awards are systematically predictable or unpredictable and the key factors driving award value have not been studied. There is, however, some prior work focusing on the predictability of patent infringement suits and likelihood of settlement or other particular outcomes. We discuss several of these studies below.

A groundbreaking set of articles by Lanjouw and Schankerman from 2000 to 2004 study the predictability and determinants of patent infringement suits.[17] Generally, the authors find that there are characteristics of litigants and patents that seem to lead to more or less litigation. For example, Lanjouw and Schankerman find that the probability of patent litigation increases if the patent is core to a set of follow-on innovations for a corporation and if a corporation has closely-related rivals and needs to maintain a reputation for protecting its intellectual property.[18] On the other hand, corporations that are part of concentrated industries or that have large patent portfolios are less likely to see litigation.[19] They argue that these findings do put smaller firms and individuals at a disadvantage since they are more likely to end up in litigation.[20] Further, they identify certain patent characteristics lending to an increased likelihood of suit, most notably a higher number of claims and more forward citations per claim.[21]

A more recent study by Allison, Lemley, and Walker addresses patent litigation in different industry sectors, and find that litigation rates and litigant characteristics vary significantly by industry, especially for the most litigated patents.[22] Generally, software and telecommunications patents are far more likely to be litigated than other types of patents; and business method patents, which are relatively new, make up a large number of the most-litigated patents. Further, the authors found that small entities that keep their patents rather than selling them tend to litigate less often than either large entities or purchasers of small entity patents. They also find that among the most-litigated patents, there are significantly more non-practicing entities than among the once-litigated patents.

Regarding outcomes of patent cases, a recent working paper by Haus and Juranek tests several theoretical predictions about settlements.[23] The authors find that between parties to a lawsuit "a higher degree of asymmetric information and larger asymmetries in stake sizes impede the solution of legal disputes by settlement."[24] This suggests that patent cases where both parties have sufficiently differing information about the patent or sufficiently large disparities in the risk of a loss will fail to settle. These findings also suggest that patent settlements may be reasonably predictable.

Damage awards themselves are one of the least-studied aspects of patent litigation. One study by David Opderbeck addressed award value in a limited study of awards from 2002 to 2007.[25] Opderbeck analyzed the distribution of patent infringement damage awards and looked at their simple correlations with the field of art and type of remedy. He found "no overriding patterns to the awards, except for some varying degrees of correlation between the size of award and the field of art or type of remedy."[26] However, given his limited dataset, he could not assess the degree of predictability or make any causal statements about factors that may contribute to award value. To date, we are unaware of any empirical studies that attempt to explain this relationship.

The literature to date demonstrates that patent litigation is reasonably predictable and suggests that certain outcomes of patent litigation may follow predictable patterns. However, the core question of the predictability of infringement damages has remained unanswered. From a practical perspective, this question is critical given the high stakes for both innovators in asserting their rights and accused infringers in avoiding unjust outcomes. Moreover, predictability of patent damages is fundamental to the normative tenets of patent policy.

Put succinctly, the incentive structure underlying the patent grant breaks down if patent damages are unpredictable. In order for exclusivity to provide meaningful rewards for disclosure of useful and novel inventions, the value of such exclusivity must be commensurate with the value disclosed. This requires the value of exclusivity to follow deterministic patterns – *i.e.*, to not vary randomly. In turn, this requires the value of harm caused by the infringement of such exclusivity to not be random. Given that, by law, infringement damages must "compensate for the infringement" of patent rights, if infringement damages are found to be unpredictable, then one of two things may be true. Either infringement damages as awarded in patent litigation verdicts are disconnected from the harm actually caused by patent infringement – that is, the awards are random even if the underlying harm is not – or such harm is itself non-deterministic.

That is, if patent infringement awards are unpredictable, then either the system of granting patents, or the system of litigating them, or both, are fundamentally flawed. With this in mind, the

evidence. *See* Patent Reform Act of 2009, S. 515 § 4 (proposed amendment to 35 U.S.C. § 284(b)(1)).

[15] See 2009 Senate Report, *supra* note 3 ("damage awards . . . are too often excessive and untethered from the harm that compensatory damages are intended to measure").

[16] See, e.g., Lucent Techs., Inc. v. Gateway, Inc., 580 F.3d 1301, 1301 (Fed. Cir. 2009); ResQNet.com, Inc. v. Lansa, Inc., 594 F.3d 860 (Fed. Cir. 2010). Two district court opinions authored by Chief Judge Rader of the Federal Circuit, sitting by designation, also reflect this view. *See* Cornell Univ. v. Hewlett-Packard Co., 609 F. Supp. 2d 279 (N.D.N.Y. 2009) (C.J. Rader sitting by designation); IP Innovation LLC v. Red Hat Inc., No. 2:07-CV-447 (RRR), 2010 WL 986620 (E.D. Tex. Mar. 2, 2010) (C.J. Rader sitting by designation). Another Federal Circuit opinion reiterated the principles articulated in *Lucent* and *ResQNet* in reversing the district court's denial of defendant's F.R.C.P. 59(a) motion for a new trial on grounds that the damages awarded by the jury were "'clearly not supported by the evidence' and 'based only on speculation or guesswork.'" WordTech Sys., Inc. v. Integrated Network Solutions, Inc., 609 F.3d 1308, 1319 (Fed. Cir. 2010), (quoting Del Monte Dunes at Monterey, Ltd. v. City of Monterey, 95 F.3d 1422, 1435 (9th Cir. 1996)). And the Federal Circuit further supported this line of cases with its decision in *Uniloc USA, Inc. v. Microsoft Corp.*, ...F.3d..., 2011 WL 9738 at *43 (Fed. Cir. Jan. 4, 2011).

[17] See e.g., Lanjouw, J. O. and Mark Schankerman, *Characteristics of Patent Litigation: A Window on Competition*, Rand J. Econ. Vol. 32, no. 1, pp. 129–51 (2001); Lanjouw, J. O. and Mark Schankerman, *Protecting Intellectual Property Rights: Are Small Firms Handicapped?*, J. L. and Econ. Vol. XLVII, no. 1. pp. 45–74 (2004); Lanjouw, J. O. and Mark Schankerman, *Patent Quality and Research Productivity: Measuring Innovation with Multiple Indicators*, Econ. J. Vol. 114, pp. 441–65 (2004).

[18] Id. Lanjouw and Schankerman (2001) at 129–30.

[19] Lanjouw and Schankerman (2004a) at 48.

[20] Id. at 47–9.

[21] *Id.* at 131.

[22] John R. Allison, Mark A. Lemley & J.H. Walker, *Extreme Value or Trolls on Top? The Characteristics of the Most Litigated Patents*, 158 U.Penn.L.Rev. 1 (2009) (studying litigation rates of patents in specific industries). However, this study does not address the outcomes of the litigation, but notes "that is the subject of a companion piece by the authors, tentatively entitled Patent Quality and Risk Aversion Among Repeat Patent Litigants." *Id.* at 5 n. 14.

[23] Axel Haus and Steffen Juranek, "Law and Economics of Litigation: New Insights from Patents," working paper dated April 2012.

[24] Id. at 3.

[25] David W. Opderbeck, *Patent Damages Reform and the Shape of Patent Law*, 89 B.U.L.Rev. 127 (2009).

[26] *Id.* at 149.

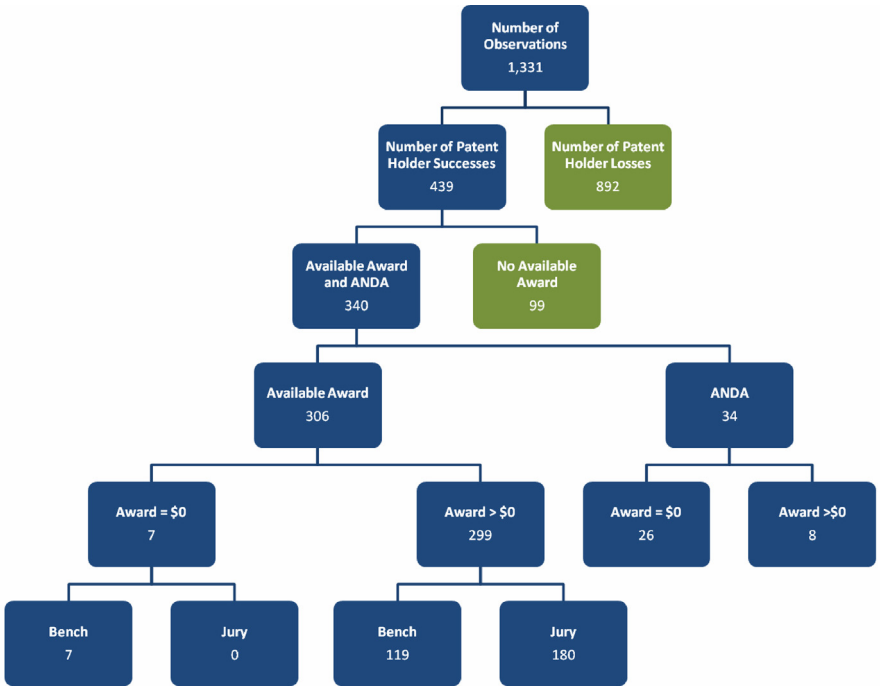

Fig. 1. Description of the final case information database 1995–2008.

following sections seek to answer whether, and the extent to which, patent damages are systematically unpredictable or whether they can be explained using available explanatory factors.

3. Data

We build a comprehensive dataset of patent awards and attempts, which includes a series of variables from a variety of sources that are subsequently used to explain the size of awards in the dataset. This section discusses dataset construction and provides first-order characteristics of the information we have analyzed. We also emphasize some interesting patterns in the raw data, before presenting regression analyses in the next section.

3.1. Dataset

To start, our analysis requires comprehensive information about damage awards in litigated patent cases. As part of its intellectual property (IP) dispute analysis practice, which provides IP litigation and valuation services, PricewaterhouseCoopers LLP (PwC) has collected an extensive database on the complete set of patent case final rulings and damage awards as reported by Westlaw. PricewaterhouseCoopers identified final decisions at summary judgment and at trial recorded in two WestLaw databases, Federal Intellectual Property – Cases (FIP-CS) and Combined Jury Verdicts and Settlements (JV-ALL), as well as in corresponding PACER records.[27] Information in the PwC database includes party names, the industry of the potential infringer, the presiding court at the time of the decision, the deciding body (bench or jury), the year of decision, the time to trial, and the associated damage awards with their component parts (where available). PwC updates its dataset every year and uses it to issue an annual report on statistics and trends in patent litigation and damages.[28] PwC licensed to us the proprietary dataset underlying their reports for the years 1995 through 2008 to start the process of building the dataset for this study. We carefully investigated each of the cases identified in PwC's original database to determine the nature of the intellectual property at issue and to verify that damage awards pertaining to the same litigated case were appropriately combined. After making a series of data cleaning changes, this process yielded a final case information database that is summarized in Fig. 1.

Our database relies on patent lawsuits reported in Westlaw, but it may be the case that not all patent suits decided on the merits appear in the databases. Further, due to the lack of reporting requirements for damage amounts, not all cases with a patent holder win has an observable damage award. The reporting standards have gotten increasingly better over time due to the E-Government Act of 2002, which mandated public access to all federal court opinions. However, this Act took some time to implement, so it is likely that some decisions were not reported prior to 2005 (approximately). However, patent cases with large damage amounts are usually associated with important legal precedent and so are very likely to have published opinions. To the extent that our dataset is missing awards, the reporting biases against small and common cases. If anything then, the median and mean damage awards described below should be lower.

A total of 1331 cases were identified, of which the trial court ruled there was infringement in 439. Among these, courts awarded damages in 340 cases – with post-judgment settlement by the parties being the most common reason no award data was found. These 340 cases represent the set of observations examined in this analysis, with the identified total damages award level representing the main dependent variable of interest.[29] The level of some of

[27] PwC 2009 Patent Litigation Study available at: http://www.pwc.com/us/en/forensic-services/publications/assets/2009-patent-litigation-study.pdf.

[28] The most recent PwC studies are available at: http://www.pwc.com/us/en/forensic-services/publications/patent-litigation-study.jhtml. The PwC annual reports were often cited in the patent reform debates that preceded the passage of the America Invests Act.

[29] The 340 cases include those involving Abbreviated New Drug Applications (ANDAs) where lost profits and reasonable royalties are not available remedies. To avoid losing these cases in the regression analysis they are coded as having $0 award (if there were no costs awarded). Because some total damages amounts include costs that cannot be separated out, all total awards include costs and attorneys fees, where

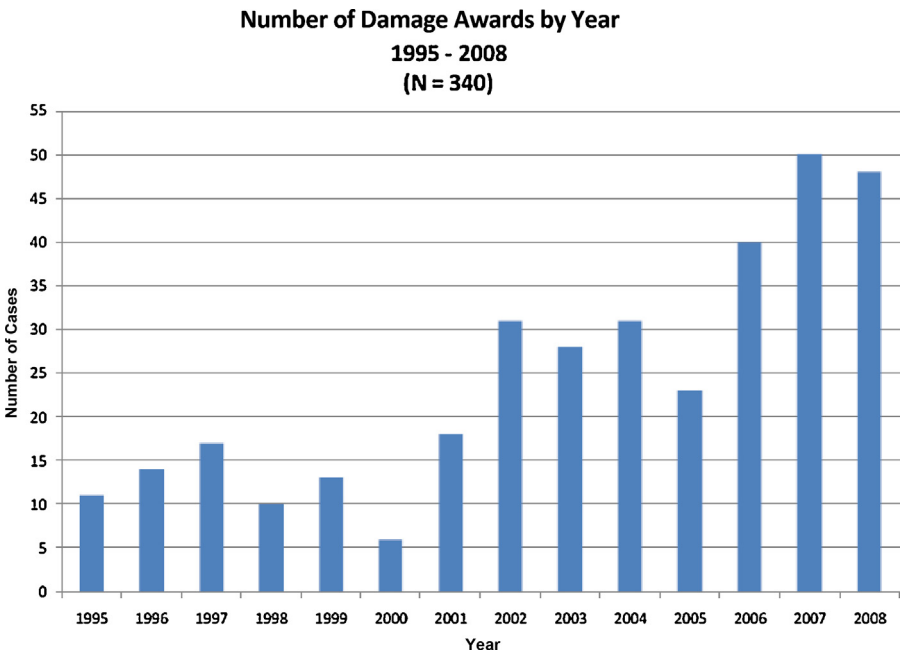

Fig. 2. Number of damage awards by year.

these awards may have changed on post-trial review and appeal; however, attention is focused only on the initial damage awards granted at the district court level.[30] To compare across years, we used the Consumer Price Index to translate damage awards levels from their nominal amounts into 2008 dollars.

3.2. Characteristics of the award distribution

Fig. 2 displays the count of observations in the datatset by year of decision, from 1995 through 2008.

This graphic representation underlines the fact that on a year-by-year basis, the number of patent damage awards granted is quite small. As a consequence – and particularly since one or two large awards can skew these distributions substantially – one should be careful to not attribute too much significance to differences in observed damages from year to year.[31] In fact, when controlling for the year of the decision in some of the regressions below it can be shown that an independent time trend is negatively correlated with damage award amounts.

To facilitate comparison with previous studies, annual summaries of the distributions of awards in the dataset are presented. Table 1 provides a more complete picture of these distributions, by including the quartiles as well as medians. Taking 2004 as an example, after adjusting the awards to 2008 dollars, the lowest award that year was $40,000 and the highest award that year was $175.1 million. In between those amounts though, 25% of the awards were under $540,000, 50% of the awards were under $4.3 million, and 75% of the awards were under $29.0 million. Annual distributions for other years behave in similar fashion.

Fig. 3 shows the differences in the median and average damages awards by year.

Although there is an underlying stability of the median over time, the increasing skewness of the awards data is evident from Table 1 and Fig. 3 – for example, when they occur, outliers generate large differences between the average and the median award levels in particular years. Also, although visually it might appear that awards are increasing on average over time, our regression analysis suggests a negative time trend, as discussed in Section 4.2.

Taken together, Table 1 and Fig. 3 demonstrate an underlying stability of the distribution over time. This lack of annual variation motivates a description of the characteristics of the *entire* distribution of awards over the whole time period for which data is available.

A straightforward graphical presentation of the entire awards distribution is shown in Fig. 4.

Fig. 4 is a histogram of awards, broken down into increasing award-level categories. Across the dataset, 74 of the cases have damage awards of less than $500,000, representing 24.2% of all cases during the time period. Reading from left to right in the figure, 49 cases have award values between $500,000 and $2 million; 34 between $2 and $5 million; 33 between $5 and $10 million, 42

available. Further, seven non-ANDA cases have a true award of $0. In these cases, the trier-of-fact determined that the patent holders did not bear their burden of proof on damages. Also, we removed the ANDA cases from certain figures (namely Table 1 and Figs. 3 and 4) because we could not otherwise control for those cases and did not want to obfuscate the trends of the non-zero damage awards (this was the more conservative route). The total number of cases without ANDA cases is 306 rather than 340.

[30] We acknowledge that results could differ if appeal-adjusted award values were used. We note that a range of things may happen following a district court decision, such as remittitur, post-trial settlement or appeals, and resulting awards may be changed or vacated altogether. We opt to study district court awards to provide a measure of award value at a consistent stage in the litigation process (as post-trial procedures will vary case-to-case). We also seek to lay groundwork for future analysis of whether appeals matter at a systematic level and, if so, how this changes our understanding of the predictability of infringement awards, the value of the rights infringed and resulting incentives to innovate. Also, to be clear, we define awards based on the trier of fact in the case. For cases decided by a jury, the base amounts are those awarded in the jury verdict. For cases decided by a judge, the base amounts are those in the final judgments. Base awards are for direct infringement only (including price erosion and convoyed sales where awarded). They do not include appeals or, in the case of jury awards, remittiturs by the bench. Where available, associated interest and enhanced damages for willfulness are added to the base amounts to arrive at the total award.

[31] Another reason for caution in making year-to-year comparisons is because of the E-Government Act of 2002 (Pub.L. 107-347, 116 Stat. 2899, 44 U.S.C. § 101, H.R. 2458/S. 803) which applied to the federal judiciary and mandated public electronic access to all written court case opinions. This Act could account for the increase in cases starting in 2002 and going through 2008 as more courts implemented the requirements in the Act.

Table 1
Distribution of patent damage awards by year ($ in millions, 2008) 1995–2008 ($N = 306$).

Year	Minimum	First quartile	Median	Third quartile	Maximum
1995	$0.03	$1.38	$5.07	$16.32	$87.52
1996	$0.02	$0.37	$3.57	$22.68	$130.36
1997	$0.30	$1.55	$7.70	$24.03	$97.59
1998	$0.01	$2.18	$3.81	$10.63	$225.87
1999	$0.28	$1.95	$7.35	$20.97	$125.35
2000	$0.48	$0.61	$3.02	$6.59	$16.54
2001	$0.00	$0.08	$1.58	$16.91	$94.87
2002	$0.00	$0.61	$5.15	$30.77	$117.41
2003	$0.08	$0.70	$10.41	$19.93	$609.17
2004	$0.04	$0.54	$4.27	$28.99	$175.09
2005	$0.00	$1.92	$8.23	$26.92	$141.14
2006	$0.01	$0.44	$2.94	$32.22	$327.76
2007	$0.00	$0.14	$1.11	$18.12	$1597.11
2008	$0.00	$0.66	$2.88	$27.18	$1223.88

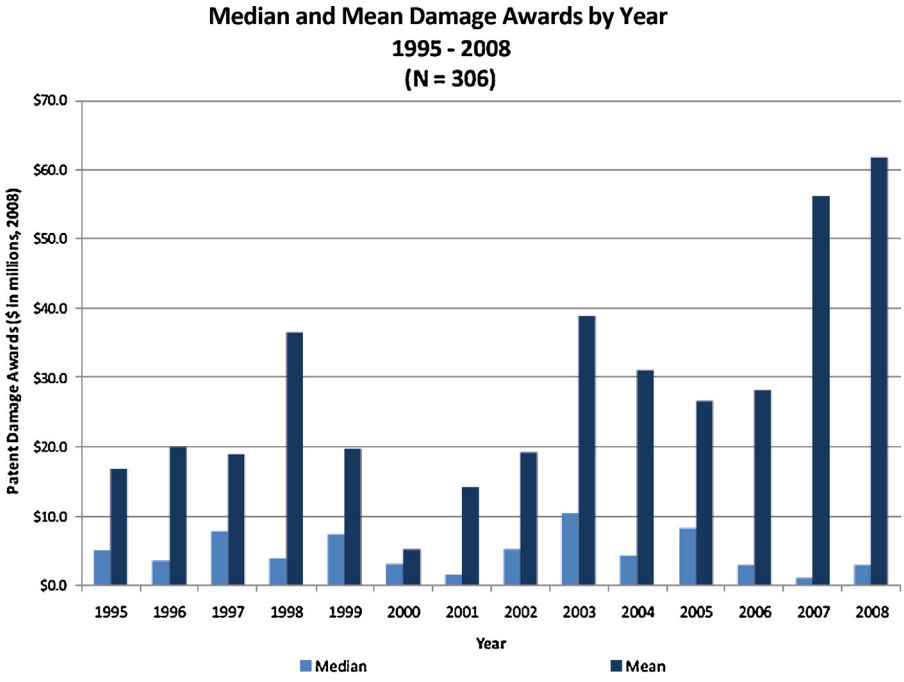

Fig. 3. Median and mean damage awards by year.

between $10 and $25 million, 29 between $25 and $50 million, 26 between $50 and $100 million and 11 between $100 and $200 million. Of particular note in Fig. 4 is the very last bar on the right, representing damage awards of over $200 million. A total of eight cases fall into this highest category of damage awards, which represents 2.4% of the number of all awards during the 1995 through 2008 period. Together, these eight cases represent 47.6% of the collective damages in *all* the non-ANDA cases from 1995 until 2008.

While more details about the determination of awards will be discussed in the regression analysis described below, a descriptive analysis of the underlying distribution of damage awards is revealing about concerns regarding the unpredictability of patent damage awards. Cutting the data several ways shows that the distribution exhibits a great deal of skewness; a very small number of very large damage awards are not representative of what has happened across all cases.[32] Additionally, median values have exhibited stability over time.

The observed skewness in the distribution is not particularly surprising. Previous research has consistently found that the distribution of patent values, especially measured in the number of times a patent is cited by other later patents, exhibits a similar skew. All else equal, we would expect to find that the distribution of patent awards reflects the underlying value of the patents. To the extent that cases with greater uncertainty about damage awards are less likely to settle (as the theoretical literature on settlement suggests), the cases with damage awards should exhibit at least much skewness as the underlying patent values.[33]

[32] This may yet be another example of the behavioral bias that occurs when individuals "overreact" to the very low probability, but very bad outcomes. See, e.g., Cass R. Sunstein and Richard Zeckhauser, "Overreaction to Fearsome Risks," HKS Faculty Research Working Paper Series, December 2008.

[33] See e.g., Bronwyn H. Hall, Adam B. Jaffe and Manuel Trajtenberg, "The NBER Patent Citation Data File: Lessons, Insights and Methodological Tools," NBER Working Paper No. 8498, October 2001, *and* Jean O. Lanjouw and Mark Schankerman, "Stylized Facts of Patent Litigation: Value, Scope, and Ownership," NBER Working Paper No. 6297, December 1997 for the skewness of the underlying patent values. *See e.g.* Lucian Bebchuk, "Litigation and Settlement under Imperfect Information," *Rand Journal of Economics*, 15, 1984, *and* Kathryn E. Spier, "The Dynamics of Pretrial Negotiation," *Review of Economic Studies*, 59, 1992 for examples of theoretical discussions of uncertainty and settlement.

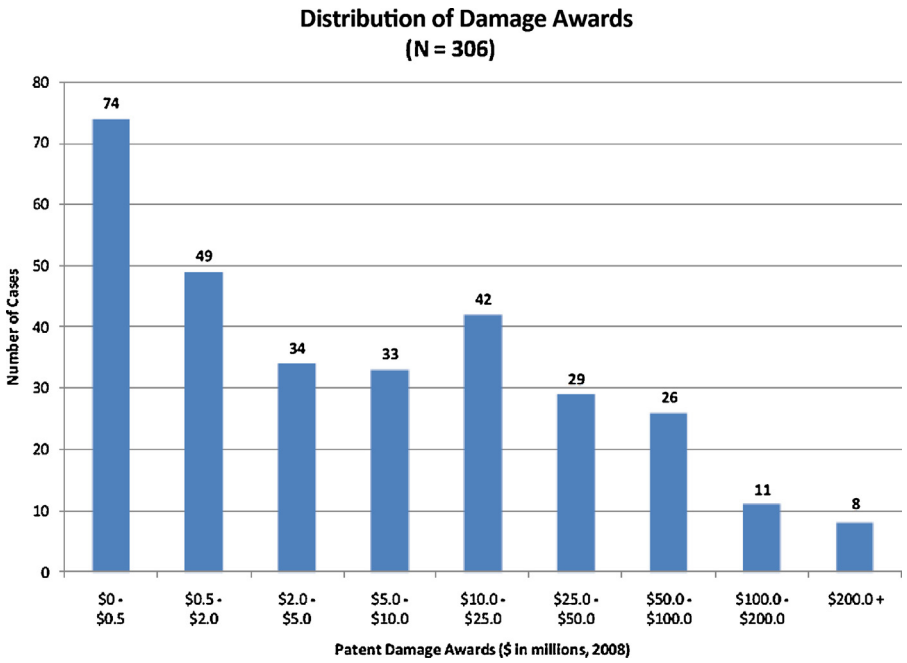

Fig. 4. Distribution of damage awards.

3.3. Explanatory variables

To complement the damage awards information, we also assembled various series of data that could potentially explain the level of damages in each case. All the explanatory variables used are summarized in Table 2 and can be divided into three separate categories; for a full list of variables coded, see Appendix 1. The first category is information derived from the record in each individual case, with key factors such as whether the case was decided by a judge or a jury and whether a lost profit or a reasonable royalty damages theory was utilized in determining the level of the award, if available. We also look at the time between the case filing and the decision date as well as the date of the decision. Based on the common concern that juries award damages that are higher than their underlying value would justify, we would expect damages awarded by juries to be higher than those awarded by a judge. Also, the time from filing the complaint to the date of decision could be a proxy for the complexity of a case. All else equal, we would expect more complex cases to be associated with higher value patent portfolios and so higher awards. Finally, given the concern over the increased number of patent cases and the conventional wisdom that patent awards are increasing over time, we would expect the time trend associated with the decision dates to be positive.

The second category of variables represents information about the litigants in each case. This includes the identity of both the plaintiff and the defendant in each case – *i.e.*, if it is an individual, a firm, a government entity or a nonprofit organization. The corporate litigants are further broken down into various industry categories and by firm size. Specifically we look to see if the litigants are public and if they belong in the Fortune 1000. Both variables are proxies for the size of the litigants since obtaining actual revenues and profits consistently for all the litigants is not possible given the data available. Often larger firms have the resources to develop highly valuable patents and they also have the "deep pockets" necessary to protect those patents in court. All else equal, we expect that cases involving large firms will result in higher damage awards.

The third category of variables draws on the economic literature of patent value mentioned above. These data include publicly available information on various characteristics of patents, including information about their assignees, number of claims, and counts of their citations in subsequent patents. Economists have argued that patents embodying more substantial or valuable intellectual property often have more claims and are cited more often by later patents.[34] By including number of claims or appending citation information to the data for each case, it can be determined whether a particular measure of a patent's value is associated with the court's determination of infringement award levels. For example, based on previous findings, we would expect cases involving more patents-at-issue, older patents, more patent claims, and more references to the patents-at-issue by later patents to have higher awards. In other words, cases with more valuable patent portfolios should result in larger damages amounts.

All of the case identification and variable coding are limited to the information that could be found in Westlaw, Lexis, PACER, and the NBER patent database, in addition to information on websites like Google, Manta, Hoover's Online, Fortune, and EDGAR (for company SEC filings).[35]

4. Empirical analysis

4.1. Overall explanation analysis

Using the dataset described in Section 3, we first attempt to determine whether patent damage awards are systematically explained by *ex ante* factors. Because our dataset does not contain the outcome of every patent case filed, we cannot create a model to predict the expected value of damages from the outset of a case. However, we can develop a model that explains damages conditional on the patent being found valid and infringed and the parties

[34] *See* Allison et al., *Valuable Patents*, 92 Geo. L.J., 435 (2004).

[35] The databases can be found at the following websites – Westlaw: https://lawschool.westlaw.com; Lexis: http://www.lexisnexis.com/lawschool; PACER: http://www.pacer.gov; NBER patent database: http://elsa.berkeley.edu/~bhhall/patents.html and https://sites.google.com/site/patentdataproject/Home; Google: http://www.google.com; Manta: http://www.manta.com; Hoover's Online: http://www.hoovers.com; Fortune 1000: http://money.cnn.com/magazines/fortune/fortune500/2009/full_list/; and EDGAR: http://www.sec.gov/edgar.shtml.

Table 2
Summary of variables.

Variable groups	Description	Sources
Category 1: case information		
Identifiers	Variables including a unique ID assigned by the authors, the docket number of the case, and the full names of the first listed plaintiff and defendant in the case.	PwC database, Google, Westlaw, and PACER
Dates	Variables including the year of the original award in district court, date the complaint for case was filed, the earliest start date of trial on validity, infringement, or damages, and the number of days between the trial start date and the complaint date.	PwC database, Google, Westlaw, and PACER
Location	Variables including where the case was litigated, including state, circuit, and court.	PwC database, Google, Westlaw, and PACER
Other case information	Variables determining if the case contained a summary judgment for the patent holder on validity and/or infringement, if the case involved an invalidated patent-at-issue, and if the patent holder was successful in its patent claims.	PwC database, Google, Westlaw, and PACER
Damage awards	If the patent holder was successful, variables for the total award amount, lost profits, reasonable royalties, prejudgment interest, enhanced damages, price erosion damages, and other damages. Also included are whether or not the case settled before damages were awarded, whether or not the case resulted in only an injunction, and whether or not the case was an ANDA filing.	PwC database, Google, Westlaw, and PACER
Category 2: litigant information		
General assignee	Includes number of patent assignees associated with the patents-at-issue in the case, the names of the assignees, if one of the assignee(s) is the first named plaintiff or defendant in the case (can be both), if the plaintiff name listed is an assignee (patent holder), and if the patent holder markets or manufactures its technology covered by the patent.	PwC database, Google, Westlaw, PACER, and NBER patent database
NBER assignee	Dummy variables from the 2002 NBER database which coded the Assignee(s) as "Unassigned," "US, Non-Government," Non-US, Non-Government,", "US, Individual," "Non-US, Individual," "US Government," or "Non-US, Government."	NBER patent database
Assignee identifiers	Includes the variables determining whether or not the first named plaintiff or defendant are an individual, private entity, public entity, university, part of the U.S. government, a domestic entity, foreign entity, part of the 2009 Fortune 500 list, part of the 2009 Fortune 1000 list, a subsidiary of a parent company.	EDGAR, Manta, Hoover's Online, Westlaw, and Fortune 1000
Assignee parent identifiers	Variables for the parent companies of the plaintiff or defendant listed if it was a subsidiary that include whether or not the parent company is a private entity, public entity, domestic entity, foreign entity, part of the 2009 Fortune 500 list, part of the 2009 Fortune 1000 list, if the first named plaintiff or defendant is owned by a joint venture (2 parents or more).	EDGAR, Manta, Hoover's Online, Westlaw, and Fortune 1000
SIC codes	Variables identifying the 2-, 3-, and 4- digit SIC codes for the potential infringers.	NBER patent database, Google, and Westlaw
Category 3: patent(s)-at-issue information		
General patent	Variables identifying the number of patent(s) at issue in the case and their type as either utility, reissue, design, or application number.	NBER patent database, Google, and Westlaw
Patent classification	Includes variables for all patents-at-issue such as application year calculated for minimum and maximum (minimums and maxima differ for cases with multiple patents-at-issue and are the same for cases with only one patent-at-issue); grant date year calculated for minimum and maximum; grant date calculated for minimum and maximum; age of the oldest and youngest patent-at-issue in a case calculated for minimum and maximum; number of claims calculated for minimum, maximum, average and total; number of forward citations through 2002 from the NBER 2002 data, calculated for minimum, maximum and average; number of forward citations through 2010 if the 2002 forward citations were not available, calculated for minimum, maximum and average; the IPC4 classification listed first on the patent; and the PTO main classification for each patent listed in the case.	NBER patent database, Google, and Westlaw

not settling. In ongoing research, we delve more deeply into the expected value of a given filed patent case.[36]

The regression analyses presented below attempt to determine how much of the variation in patent damage awards can be explained by the factors we assembled regarding the cases, litigants and patents-at issue. Using all 340 patent damage awards,[37] we ran several models to see which collection of factors could best be used to explain the variation in observed patent damages from 1995 through 2008. Because the dependent variable remains the same for most of the models, the R^2 goodness of fit measure can be used to compare the different models. The summary statistics from the models of best fit are outlined in Table 3.

Model (1) in Table 3 is our "naïve" model that contains almost all of the variables listed in Appendix 1 as controls. Because of the skewness inherent in the distribution of damages, we use as the dependent variable the log of damages in 2008 dollars. This transformation is necessary to normalize damages and allow for a better model, as discussed further below. Also, to minimize multicollinearity that could artificially increase the R^2 goodness of fit measure, the control variables were tested to ensure none were highly correlated with any other. For pairs of controls that were highly correlated, the one of the pair most correlated with the log of damages (the dependent variable) was retained. Robust standard errors were also used to mitigate any heteroscedasticity in the model.

This naïve model does quite well as it explains about 64% of the variation in the observed patent damage awards, as represented by

[36] The conditional nature of our analysis could potentially generate concerns about selection, if cases that settle are systematically different from cases that do not. Notably, the empirical findings of Haus and Juranek (cited above) suggest *greater* predictability in patent cases that settle, mirroring the theoretical literature on settlement (see Bebchuk, 1984; Spier, 1992). In any event, we are looking for predictability in a subset of cases filed, and we do not directly address the predictability of settlements. Also, we note that another possible approach could be to perform some of our regressions using a dataset constructed at the patent-level rather than case-level (*e.g.*, examining awards and outcomes on a patent-by-patent basis), though this is complicated by the fact that many of the cases cover multiple patents and that damages are determined at the level of the case.

[37] In order to compare all patent infringement cases, ANDA cases are included with $0 damages amounts when costs in those cases were not awarded in the regression. In most of the regressions fewer than 340 cases are used in the model due to missing data.

Table 3
Summary of models that explain patent damage awards.

Dependent variable = patent damage awards in 2008 $	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)
R^2	0.6399	0.7340	0.7403	0.7427	0.7561	0.7702	0.4457
Adjusted R^2	0.5368	0.6566	0.6621	0.6599	0.6618	0.6696	0.2030
F	5.88	15.15	14.40	20.44	20.12	19.50	2.54
$(k-1, N-k)$	(75, 262)	(76, 261)	(78, 259)	(82, 255)	(94, 243)	(95, 217)	(95, 217)
Sample size (N)	338	338	338	338	338	313	313
Standard errors	Robust	Robust	Robust	Robust	Robust	Robust	Robust
Dependent variable type	Log	Log	Log	Log	Log	Log	Linear
Independent variables	Base controls	Model (1) + ANDA dummy	Model (2) + Interactions	Model (3) + non-parametric total patents	Model (4) + year dummies	Model (5) + avg. forward citations	Model (6)

Full regression results are on file with the authors.

an R^2 of 0.6399.[38] However, we thought it was possible to create an even better model by adding in or creating additional controls. In order to most effectively use the data to generate additional explanatory power, we conducted a variety of detailed manipulations on several of the variables. For example, we constructed interaction terms for certain key variables. As an illustration, the data contains information about who decided damages (judge or jury) in each case and the particular damages theory (lost profits or reasonable royalties) utilized, and based on these individual indicator variables, we created an interaction variable for cases decided by juries using the reasonable royalty standard. We also considered nonlinear representations of some regressors. Models (2) through (6) in Table 3 show how each modification improved the overall explanation of the variation in patent damage awards.

Model (2) is the naïve model plus an additional control for whether the case was an ANDA case. Because ANDA cases generally have $0 awards, as a group they are different from standard patent infringement cases. Rather than drop these observations, we chose to control for them in Model (2). This addition immediately increased the explanatory power of the model as represented by its R^2 of 0.7340 (adjusted R^2 = 0.6566).

Acknowledging that juries having to decide reasonable royalty damages could influence the total amount of damages awarded, we added two interaction variables (juries × reasonable royalties and juries × lost profits) to create Model (3). These additions result in a minor improvement over Model (2), explaining 74% of the variation in damages (adjusted R^2 = 0.6621).

Model (4) uses Model (3) but replaces the single variable representing the number of patents-at-issue in the case with a non-parametric set of variables. This substitution suggests there may be diminishing marginal returns with respect to damages for each patent-at-issue in the case. Whereas a single variable suggests that each additional patent-at-issue contributes equally to the total damages awarded, the set of non-parametric variables allows us to assess the effects of different numbers of patents-at-issue. In Model (4), the set of non-parametric variables include dummies for cases with 1, 2, 3, 4, 5–10, and over 10 patents-at-issue. As with all sets of dummy variables, one is dropped for the regression, in this situation we drop the dummy for cases with only one patent-at-issue. Again, this model provides a minor improvement over Model (3) with an R^2 of 0.7427 (adjusted R^2 = 0.6599).

In Model (5), we replace a single variable for the year of the case decision with a set of dummy variables representing each year. This alternative means of accounting for the time trend of damages does improve the overall damage award explanation, although none of the years are individually significant. This model as a whole explains 76% of the variation in patent damage awards (adjusted R^2 = 0.6618).

Finally, Model (6) takes Model (5) and adds a variable tracking the average number of forward citations for the patents-at-issue in the case. Allison et al. linked the number of forward citations to the likelihood of patent litigation,[39] and forward citations as a proxy for the inherent economic value of patents appears to be supported by this model. Model (6) explains about 77% of the variation in patent damages (adjusted R^2 = 0.6696). We note that forward citations, gathered from the NBER patent database, were not available for all cases, and therefore we dropped 25 cases due to lack of data.

The statistical models that we constructed include sets of regressors that explain between 64 and 77% of the variation in the observed patent damage awards. These results suggest that, along with analysis based on the dimensions represented by our data, infringement damages are not particularly unpredictable.[40]

It is worth noting that the dependent variable in Models (1)–(6) is the log of damage awards. The skewness in the underlying damages data suggests this was a necessary transformation to determine a model of best fit since patent damages are not determined by a straight line (especially as they get larger).[41] Graphing the residuals of the model can test the appropriateness of logging the dependent variable. For each damage award observation, we can use the estimated parameters from the regressions to calculate a "predicted value" of the award amount given the data on the explanatory variables for that observation. The difference between the actual damage amount and this "predicted value" (*i.e.*, the residual) represents how well the model does in terms of explaining each observation. In Fig. 5, we plot these residual values for Model (5) as an example.[42]

Fig. 5 illustrates that the residuals are reasonably normally distributed, suggesting that our logged model is appropriate and that R^2 as a measure of goodness-of-fit has meaning.

Although Fig. 5 shows the distribution of the residual, it does not illustrate the actual damages awards associated with the highest residuals. In order to illustrate the relationship between the

[38] Even after taking into account the number of regressors in the model, the Adjusted R^2 still equals 0.5368.

[39] *See* Allison et al., *Valuable Patents*, *supra* note 33.

[40] These findings contrast with the suggestion in the Opderbeck study that there is no clear pattern to the observed damage awards. *See* Opderbeck, *supra* note 23, at 149.

[41] It is not uncommon to use log transformations on the dependent variable in order to put the relationship between the dependent and independent variables into a linear form.

[42] We use Model (5) for illustrative purposes as it is the Model with the highest R^2 while still retaining all observations.

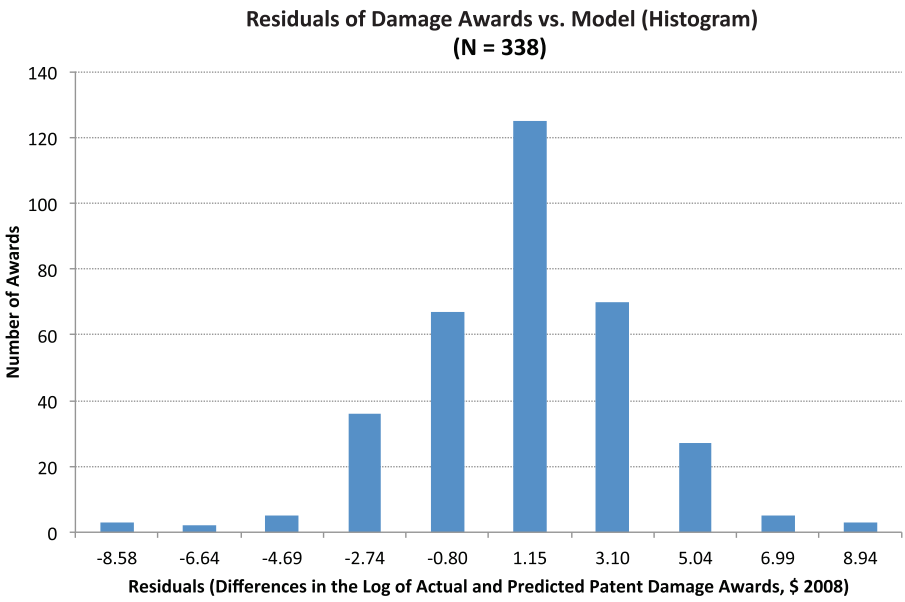

Fig. 5. Residuals of damage awards vs. model (Histogram).

model's residuals and the actual damage awards, we plot the residuals against actual damages in Fig. 6.

As can be seen in Fig. 6, none of the cases with the largest damages awards are outliers of the residuals plot. Rather, it appears that large awards, including the eight largest, are readily predictable by the model. In terms of the difference between predicted award values and observed damages, litigation outcomes do not appear to be unpredictable.

Additionally, linear versions of Models (1)–(6) in Table 3 using the same regressors have much less explanatory power. As an illustration, Model (7) in Table 3 is simply Model (6) but with no transformation to the patent damage amounts, *i.e.*, without converting the damage awards to logs. This model performs far worse than any of the others ($R^2 = 0.4457$ and adjusted $R^2 = 0.2030$).

4.2. Key factors explaining patent damage awards

While the previous models focus on the overall predictability of patent damage award levels based on observable factors, the relatively large number of regressors and the presence of interaction and higher-order terms complicates interpretation of individual explanatory factors. In this subsection, we present a streamlined version of the regression analysis, with regressors specifically chosen to assess various economic factors that may be associated with damage awards. In addition, we evaluate the role of certain litigation strategy and case-related variables that may also affect damage award levels.

The regression results are presented in Table 4. Again, the dependent variable of the regression is the natural logarithm of observed patent damage awards. Note that the number of

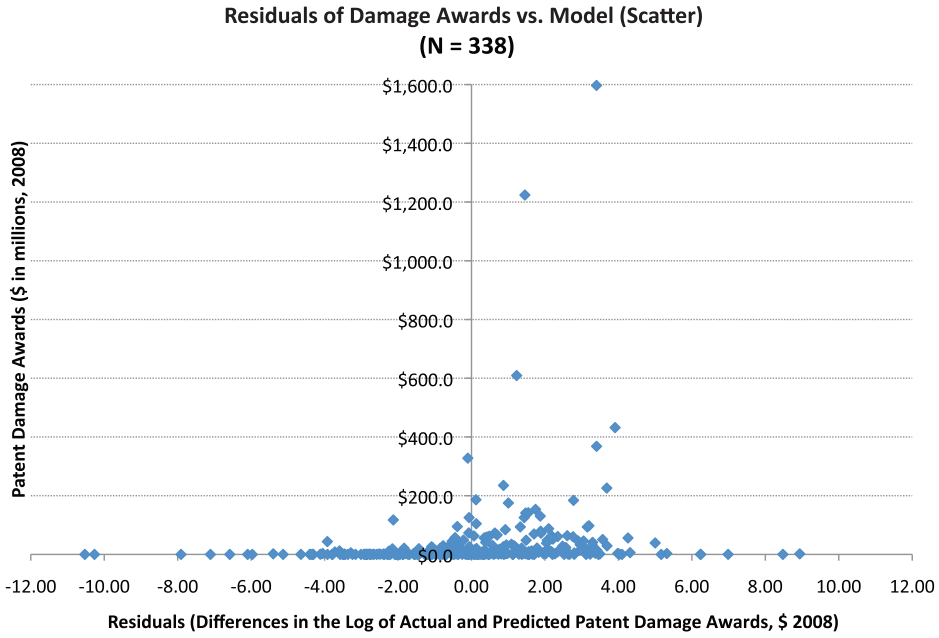

Fig. 6. Residuals of damage awards vs. model (Scatter).

Table 4
Significant factors influencing damage awards.

Dependent = log of patent damage awards in 2008 dollars	Coef.	Robust std. error	*t*	[95% conf. interval]	
Number of patents	0.15355	0.05096	3.01	0.05320	0.25391
Average age of patent	0.00015	0.00013	1.21	−0.00010	0.00040
Average number of patent claims	0.01236	0.00458	2.70	0.00335	0.02137
Average number of forward citations	0.00887	0.00476	1.86	−0.00051	0.01824
Defendant is a public company (or subsidiary)	1.46607	0.38438	3.81	0.70904	2.22311
Defendant is a Fortune 500 Company (or subsidiary)	0.51771	0.61310	0.84	−0.68978	1.72520
Dummy for jury trial	2.22101	0.59807	3.71	1.04312	3.39890
Time-to-trial	0.00087	0.00022	3.98	0.00044	0.00130
Dummy for ANDA case	−11.13325	1.11577	−9.98	−13.33076	−8.93574
Year of decision (time trend)	−0.14969	0.04889	−3.06	−0.24597	−0.05340
Constant	310.66540	97.71406	3.18	118.21770	503.11310

observations in this dataset is somewhat smaller, as several cases needed to be dropped due to incomplete data for some of the important explanatory variables. Despite the much smaller number of explanatory variables (just ten) in this regression, the overall fit of the regression remains relatively strong.

The focus of this empirical exercise, however, is on the significance of the individual regressors. We start at the top of Table 4 with four variables regarding the patents-at-issue in the decided cases. The number of patents varies by case (ranging from one to twenty-nine patents), and the higher number of patents, the less likely the case is to settle as there are more claims to defend against. The portfolio of patents are often more valuable than a single patent, so we would expect the damage awards in these cases to be higher. These results indicate that cases with more patents do tend to have higher damage award values, all else equal. This factor had high statistical significance, with a *t*-statistic of 3.01.

The next three explanatory variables capture features of the patents in each of the cases for which damages were awarded. Since there may be several patents associated with a given case, we included averages for each of these features calculated across the patents in that case. For example, based on the issue date of the patent and the time of the decision, we determined the age of each patent associated with the case and computed the average among all these patents. Cases associated with more mature patents – perhaps those for which infringement might have generated a higher level of lost profits[43] – are expected to have a correspondingly higher level of damage award values. Again, the coefficient on average patent age is positive and statistically significant.

The next two variables are meant to proxy for the inherent economic value associated with the patents-at-issue in the cases. For each case, we computed the average number of claims in the relevant patents; our hypothesis is that patents with more claims might be expected to cover more intellectual property. The resulting damage awards were indeed higher in cases where the patents had more claims, potentially reflecting a higher royalty rate or greater amount of lost profits related to more intellectual property. Also, the significance of the intellectual property associated with patents is often captured by the number of times the patent is cited in other patents granted in the future. Our regression results support this interpretation as well, as damages are higher in cases where the average patent is cited more often in future patents. The regression coefficients on both the patent claims and forward citations variables are statistically significant.

The next set of reported coefficients is associated with the litigants involved in the cases. Unfortunately, we do not have specific information about the infringing activity that would allow us to directly measure lost profits or reasonable royalties on a case-by-case basis. We instead use variables associated with the size and revenue potential of defendants to proxy for the scope of what these damage values might be. We expect larger firms to be associated with larger awards when they actually go to judgment rather than settle. We include dummy variables indicating cases where the defendant is a public company (as opposed to a private company, an individual or a government organization) and another dummy variable for those companies that are in the Fortune 500 (the 500 largest companies by revenue in the United States). Both of these dummy variables are positive, though only the public company proxy is statistically significant at traditional precision levels. Though these proxies are imperfect, these findings do provide some consistent evidence regarding revenue potential.

The last set of variables in the regression focus on litigation-related factors, including case strategy choices that may be affected by litigants. We included a dummy variable for cases that were decided by juries expecting that awards issued by juries to be higher than those issued by judges all else equal. Such cases were indeed associated with significantly higher damage awards. Of course, selection bias is expected in relation to the jury factor, as litigants generally choose whether a case is decided by judge or jury and may decide strategically based on their award expectations, risk appetite, budgetary constraints and other factors. The data indicates that jury-decided cases generally have higher awards; this does not prove that juries cause awards to be higher, all else equal. Notably, removing the jury variable does not substantially change the results as can be shown in Table 5.

We also include a time-to-trial variable that equals the number of days between the initial complaint and the date of the decision. While there are a variety of potential explanations for why the time to trial might be longer, we believe it may serve as a proxy for the complexity of cases – with more complex cases having potentially higher damages at stake. We again also include a dummy variable for ANDA cases since as a group they are systematically different from most other cases and should be controlled for.

Finally, we included the year of the decision in the regression to control for any time trend in the damage award amounts. Interestingly, the estimated time trend is significantly negative here, indicating that all else equal damage awards have been decreasing over time. To the extent that observed damage award values may have been increasing, the results suggest that this is more due to changes in the kinds of cases involved (as captured by our control variables) as opposed to any general independent trend toward greater awards. For example, the results in Table 5 suggest that jury trials have been increasing over time. Nonetheless, to the extent there is an independent time trend it appears to be moving in the opposite direction. This gives grounds to question common assumptions that patent awards have generally been increasing; although recent awards such as the billion dollar Apple-Samsung verdict used to be unheard of in patent cases, such cases might not reflect a systematic increase in award values across the dataset.

[43] For example, increased lost profits might be expected to result from more mature patents given the increased stability of business performance and revenues over time and increased operational efficiencies enabled by more mature markets.

Table 5
Significant factors influencing damage awards with and without a jury dummy variable.

Dependent = log of patent damage awards in 2008 dollars	Model 1		Model 2	
	Coef.	*t*	Coef.	*t*
Number of patents	0.15355	3.01	0.16064	3.01
	(0.05096)		(0.05330)	
Average age of patent	0.00015	1.21	0.00008	0.59
	(0.00013)		(0.00014)	
Average number of patent claims	0.01236	2.70	0.01088	2.37
	(0.00458)		(0.00459)	
Average number of forward citations	0.00887	1.86	0.01073	2.19
	(0.00476)		(0.00491)	
Defendant is a public company (or subsidiary)	1.46607	3.81	1.68604	4.45
	(0.38438)		(0.37851)	
Defendant is a Fortune 500 company (or subsidiary)	0.51771	0.84	0.56595	0.87
	(0.61310)		(0.64928)	
Dummy for jury trial	2.22101	3.71		
	(0.59807)			
Time-to-trial	0.00087	3.98	0.00065	2.87
	(0.00022)		(0.00023)	
Dummy for ANDA case	−11.13325	−9.98	−12.72376	#####
	(1.11577)		(0.96759)	
Year of decision (time trend)	−0.14969	−3.06	−0.05202	−1.24
	(0.04889)		(0.04187)	
Constant	310.66540	3.18	116.81500	1.39
	(97.71406)		(83.95007)	
N	261		261	
R^2	0.6797		0.6479	

Robust standard errors in parentheses.

We note that the R^2 value of this analysis is lower than the values reported in Table 3. This difference is expected given the fewer variables involved in our targeted regression. However, it should also be noted that certain case variables in Table 3 may be more closely related to the determination of award value at trial than the more limited set used in the targeted analysis (*e.g.*, prejudgment interest, *etc.*). Any ex ante prediction of award value in a given case should also account for trial-specific factors.

Taken together, our regression results suggest that identifiable factors are correlated with the size of damage awards and that sensible specific factors are associated with higher or lower awards. Both of these findings provide evidence that the concerns regarding the unpredictability of patent damage awards are overstated and unfounded. We turn to potential implications of these findings in Section 5.

5. Interpretations and conclusions

As discussed in Section 1, the normative implications of our findings go to the heart of the incentive structure established by the patent system. Patent damages are intended to compensate for the harm caused by infringement.[44] As a normative construct, the patent system relies on the assumption that such "harm" is worth compensating and deserves legal protection. Yet, the underlying risk remains that infringement is merely a legal fiction with no corollary in real world economic systems.[45] If this were true, providing a legal right to receive compensation for infringement would be inappropriate and inefficient. If patents are illegitimate, the patent system would serve to redistribute wealth and likely would also impede innovation by penalizing the productive activities of accused infringers.

Accordingly, if patent awards were unpredictable, this would have dire implications for the patent system. For instance, in the best case, this could mean that only the system of granting and enforcing patents is broken, and infringement awards truly are "untethered" from reality. In the worst case, if the harm protected against by patents is random and does not follow deterministic patterns, then patents are unlikely to have any legitimate basis as forms of intellectual property.

In this study, we find that an empirical analysis based on observable factors explains a large portion of the variation in actual patent infringement awards. Moreover, several of the driving factors correspond to accepted indicators of patent quality. Our findings thus bolster the core tenets of the patent system, namely that "the progress of... the useful arts" should receive legal protection and that the exclusive patent rights are an appropriate means for such purpose.

Additionally, to the extent unpredictability has become synonymous with illegitimacy in the criticism of patent infringement awards, our findings directly counter this argument. Rather, the ability to systematically explain patent damages should inform scholarship and debate and direct focus toward continuing problems in our patent system.

Acknowledgements

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[44] 35 U.S.C. § 284.
[45] For example, certain critics argue that patents are "intellectual monopoly which afford no social value and instead are legislative creations designed to protect vested interests". *See*, *e.g.*, Boldrine and Levine, *Against Intellectual Monopoly* (2008).

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Appendix 1. List of variables and descriptions

Variable	Description	Source
Category 1: case record information		
case_ID	Unique identifier for each case	Assigned
docket_number	The docket number associate with the case	PwC database, Google, Westlaw, and PACER
P_name_1	Full name of the first plaintiff listed on the case	PwC database, Google, Westlaw, and PACER
D_name_1	Full name of the first defendant listed on the case as reported in Westlaw	PwC database, Google, Westlaw, and PACER
P_pat_owner	The plaintiff is the patent holder	PwC database, Google, Westlaw, and PACER
year_of_decision	The year associated with the leading decisions entered by PwC	PwC database, Google, Westlaw, and PACER
complaint_date	Date the complaint for the case was filed	PwC database, Google, Westlaw, and PACER
trial_start_date	The earliest start date of a trial on validity, infringement, or damages	PwC database, Google, Westlaw, and PACER
time_to_trial	The number of days between *trial_start_date* and *complaint_date*	Calculated
state	The state in which the court is located	PwC database, Google, Westlaw, and PACER
circuit	The circuit to which the court belongs, if a federal court; Additionally: 0 = the U.S. Court of Federal Claims and 12 = D.C. Circuit; State courts are left blank	PwC database, Google, Westlaw, and PACER
court	The court in which the decision on patent holder success was made	PwC database, Google, Westlaw, and PACER
jury	The decision on damages made by a jury	PwC database, Google, Westlaw, and PACER
SJ_flag	The case contained a summary judgment for the patent holder on validity and/or infringement	PwC database, Google, Westlaw, and PACER
invalid_pat_flag	The case involved an invalidated patent at issue	PwC database, Google, Westlaw, and PACER
dmg_awd_flag	The patent holder was successful in it's patent claims; *i.e.* the patent was found valid and/or infringed	PwC database, Google, Westlaw, and PACER
dmg_awd_amt	The total dollar award granted to the patent holder for the patent claims in the trial case before appeal of damages (if applicable)	PwC database, Google, Westlaw, and PACER
LP_flag	The patent holder was awarded lost profits	PwC database, Google, Westlaw, and PACER
LP_amt	The lost profits dollar award granted to the patent holder for the patent claims in the trial case before appeal of damages	PwC database, Google, Westlaw, and PACER
RR_flag	The patent holder was awarded reasonable royalties	PwC database, Google, Westlaw, and PACER
RR_amt	The reasonable royalty dollar award granted to the patent holder for the patent claims in the trial case before appeal of damages	PwC database, Google, Westlaw, and PACER
RR_rate	The percentage rate associated with the reasonable royalty dollar award granted to the patent claims in the trial case before appeal of damages	PwC database, Google, Westlaw, and PACER
RR_basis	The basis to which the reasonable royalty rate will be applied in the trial case before appeal of damages; =0 if the rate is not given in the decision or there is no rate; =1 if Sales; =2 if Profit	PwC database, Google, Westlaw, and PACER
PJI_flag	The patent holder was awarded prejudgment interest	PwC database, Google, Westlaw, and PACER
PJI_amt	The prejudgment interest dollar award granted to the patent holder for the patent claims in the trial case before appeal of damages	PwC database, Google, Westlaw, and PACER
PJI_rate	The percentage rate associated with the prejudgment interest dollar award granted to the patent claims in the trial case before appeal of damages	PwC database, Google, Westlaw, and PACER
PJI_basis	The basis from which the prejudgment interest rate is derived in the trial case before appeal of damages; =0 if the rate is not given in the decision or there is no rate; =1 if Prime Interest Rate; =2 if Treasury Bills; =3 if Statutory Rate; =4 if Cost of Capital; =5 if given but Other	PwC database, Google, Westlaw, and PACER
enh_dmg_flag	The patent holder was awarded enhanced damages	PwC database, Google, Westlaw, and PACER
enh_dmg_amt	The enhanced damages dollar award granted to the patent holder for the patent claims in the trial case before appeal of damages	PwC database, Google, Westlaw, and PACER
PE_flag	The patent holder was awarded price erosion damages	PwC database, Google, Westlaw, and PACER
PE_amt	The price erosion dollar award granted to the patent holder for the patent claims in the trial case before appeal of damages	PwC database, Google, Westlaw, and PACER
other_dmg_flag	The patent holder was awarded other damages	PwC database, Google, Westlaw, and PACER
other_dmg_amt	The other damages dollar award granted to the patent holder for the patent claims in the trial case before appeal of damages	PwC database, Google, Westlaw, and PACER
Settlement	The case settled after a finding of validity and infringement but before damages were awarded	PwC database, Google, Westlaw, and PACER
Injunction	The patent holder was awarded an injunction, but no other damages	PwC database, Google, Westlaw, and PACER
ANDA	The case involved an ANDA filing by the potential infringer (injunction and possibly costs awarded but no other damages for patent infringement)	PwC database, Google, Westlaw, and PACER
Category 2: information about litigants		
Number_Assignees	Number of patent assignees associated with the patents-at-issue in the case	NBER patent database, Google, and Westlaw
Pat_Assignee	Name of the assignee over all patents-at-issue in the case; one variable for each assignee	NBER patent database, Google, and Westlaw
Assignee_Unassigned	At least one of the patents-at-issue in the case had an assignee in the 2002 NBER patent database coded as "Unassigned"	NBER patent database
Assignee_US_Non Govt	At least one of the patents-at-issue in the case had an assignee in the 2002 NBER patent database coded as "US, Non-government"	NBER patent database
Assignee_Non US_Non Govt	At least one of the patents-at-issue in the case had an assignee in the 2002 NBER patent database coded as "Non-US, Non-government"	NBER patent database

Variable	Description	Source
Assignee_US Indiv	At least one of the patents-at-issue in the case had an assignee in the 2002 NBER patent database coded as "US, Individual"	NBER patent database
Assignee_Non US Indiv	At least one of the patents-at-issue in the case had an assignee in the 2002 NBER patent database coded as "Non-US, Individual"	NBER patent database
Assignee_US Govt	At least one of the patents-at-issue in the case had an assignee in the 2002 NBER patent database coded as "US Government"	NBER patent database
Assignee_Non US Govt	At least one of the patents-at-issue in the case had an assignee in the 2002 NBER patent database coded as "Non-US Government"	NBER patent database
P_Assignee	At least one of the patent assignee(s) is the first named plaintiff in the case	Calculated
D_Assignee	At least one of the patent assignee(s) is the first named defendant in the case	Calculated
Patent_Manuf_Mkt_Tech	The patent holder markets or manufactures its technology covered by the patent; =1 yes; =0 no; =2 unclear	PwC database, Google, Westlaw, and PACER
P_Individual_C	The first named plaintiff is an individual	EDGAR, Manta, Hoover's Online, and Westlaw
P_Private Entity_C	The first named plaintiff is a private entity	EDGAR, Manta, Hoover's Online, and Westlaw
P_Public Entity_C	The first named plaintiff is a public entity	EDGAR, Manta, Hoover's Online, and Westlaw
P_University_C	The first named plaintiff is a university	EDGAR, Manta, Hoover's Online, and Westlaw
P_US Government_C	The first named plaintiff is part of the U.S. government	EDGAR, Manta, Hoover's Online, and Westlaw
P_Domestic_C	The first named plaintiff is a domestic entity	EDGAR, Manta, Hoover's Online, and Westlaw
P_Foreign_C	The first named plaintiff is a foreign entity	EDGAR, Manta, Hoover's Online, and Westlaw
P_Fortune 500_2009_C	The first named plaintiff is part of the 2009 Fortune 500	Fortune 1000
P_Fortune 1000_2009_C	The first named plaintiff is part of the 2009 Fortune 1000	Fortune 1000
p_fortune_501_1K_2009_c	The first named plaintiff is listed in the Fortune 501 to 1000 in 2009	Fortune 1000
P_Subsidiary_C	The first named plaintiff is a subsidiary of a parent company	EDGAR, Manta, Hoover's Online, and Westlaw
P_Private Entity_Par	The first named plaintiff is a subsidiary and the parent company is a private entity	EDGAR, Manta, Hoover's Online, and Westlaw
P_Public Entity_Par	The first named plaintiff is a subsidiary and the parent company is a public entity	EDGAR, Manta, Hoover's Online, and Westlaw
P_Domestic_Par	The first named plaintiff is a subsidiary and the parent company is a domestic entity	EDGAR, Manta, Hoover's Online, and Westlaw
P_Foreign_Par	The first named plaintiff is a subsidiary and the parent company is a foreign entity	EDGAR, Manta, Hoover's Online, and Westlaw
P_Fortune 500_2009_Par	The first named plaintiff is a subsidiary and the parent company is in the 2009 Fortune 500	Fortune 1000
P_Fortune 1000_2009_Par	The first named plaintiff is a subsidiary and the parent company is in the 2009 Fortune 1000	Fortune 1000
p_fortune_501_1K_2009_par	The first named plaintiff is a subsidiary and the parent company listed in the Fortune 501 to 1000 in 2009	Fortune 1000
P_Joint Venture_Par	The first named plaintiff is a subsidiary and is owned by a joint venture	EDGAR, Manta, Hoover's Online, and Westlaw
D_Individual_C	The first named defendant is an individual	EDGAR, Manta, Hoover's Online, and Westlaw
D_Private Entity_C	The first named defendant is a private entity	EDGAR, Manta, Hoover's Online, and Westlaw
D_Public Entity_C	The first named defendant is a public entity	EDGAR, Manta, Hoover's Online, and Westlaw
D_University_C	The first named defendant is a university	EDGAR, Manta, Hoover's Online, and Westlaw
D_US Government_C	The first named defendant is part of the U.S. government	EDGAR, Manta, Hoover's Online, and Westlaw
D_Domestic_C	The first named defendant is a domestic entity	EDGAR, Manta, Hoover's Online, and Westlaw
D_Foreign_C	The first named defendant is a foreign entity	EDGAR, Manta, Hoover's Online, and Westlaw
D_Fortune 500_2009_C	The first named defendant is part of the 2009 Fortune 500	Fortune 1000
D_Fortune 1000_2009_C	The first named defendant is part of the 2009 Fortune 1000	Fortune 1000
d_fortune_501_1K_2009_c	The first named defendant is listed in the Fortune 501 to 1000 in 2009	Fortune 1000
D_Subsidiary_C	The first named defendant is a subsidiary of a parent company	EDGAR, Manta, Hoover's Online, and Westlaw
D_Private Entity_Par	The first named defendant is a subsidiary and the parent company is a private entity	EDGAR, Manta, Hoover's Online, and Westlaw
D_Public Entity_Par	The first named defendant is a subsidiary and the parent company is a public entity	EDGAR, Manta, Hoover's Online, and Westlaw
D_Domestic_Par	The first named defendant is a subsidiary and the parent company is a domestic entity	EDGAR, Manta, Hoover's Online, and Westlaw
D_Foreign_Par	The first named defendant is a subsidiary and the parent company is a foreign entity	EDGAR, Manta, Hoover's Online, and Westlaw
D_Fortune 500_2009_Par	The first named defendant is a subsidiary and the parent company is in the 2009 Fortune 500	Fortune 1000
D_Fortune 1000_2009_Par	The first named defendant is a subsidiary and the parent company is in the 2009 Fortune 1000	Fortune 1000
d_fortune_501_1K_2009_par	The first named defendant is a subsidiary and the parent company listed in the Fortune 501 to 1000 in 2009	Fortune 1000
D_Joint Venture_Par	The first named defendant is a subsidiary and is owned by a joint venture	EDGAR, Manta, Hoover's Online, and Westlaw
ind_SIC2	The 2-digit SIC code for the potential infringer	NBER patent database, Google, and Westlaw
ind_sic_mining	Equals 1 if *ind_sic2* is between 10 and 14 inclusive	NBER patent database, Google, and Westlaw
ind_sic_cons	Equals 1 if ind_sic2 is between 15 and 17 inclusive	NBER patent database, Google, and Westlaw
ind_sic_manuf	Equals 1 if ind_sic2 is between 20 and 39 inclusive	NBER patent database, Google, and Westlaw
ind_sic_trans	Equals 1 if ind_sic2 is between 40 and 49 inclusive	NBER patent database, Google, and Westlaw
ind_sic_whole	Equals 1 if ind_sic2 is between 50 and 51 inclusive	NBER patent database, Google, and Westlaw
ind_sic_retail	Equals 1 if ind_sic2 is between 52 and 59 inclusive	NBER patent database, Google, and Westlaw
ind_sic_finance	Equals 1 if ind_sic2 is between 60 and 67 inclusive	NBER patent database, Google, and Westlaw
ind_sic_services	Equals 1 if ind_sic2 is between 70 and 89 inclusive	NBER patent database, Google, and Westlaw
ind_sic_pubadmin	Equals 1 if ind_sic2 is between 90 and 99 inclusive	NBER patent database, Google, and Westlaw
ind_SIC3	The 3-digit SIC code for the potential infringer	NBER patent database, Google, and Westlaw
ind_SIC4	The 4-digit SIC code for the potential infringer	NBER patent database, Google, and Westlaw
Category 3: patent(s)-at-issue information		
Number_Patents	Number of patents-at-issue in the case	Google, Westlaw, and PACER
Pat_Utility	One or more of the patents-at-issue are a utility patent	NBER patent database, Google, and Westlaw
Pat_Reissue	One or more of the patents-at-issue are a reissue patent	NBER patent database, Google, and Westlaw
Pat_Design	One or more of the patents-at-issue are a design patent	NBER patent database, Google, and Westlaw
Pat_Application	One or more of the patents-at-issue are an application number	NBER patent database, Google, and Westlaw
Pat_App_year	Application year of all patents-at-issue in the case calculated for minimum and maximum	NBER patent database, Google, and Westlaw
Pat_Gyear	Grant date year of all patents-at-issue in the case, calculated for minimum and maximum	NBER patent database, Google, and Westlaw

Variable	Description	Source
Pat_Gdate	Grant date of all patents-at-issue in the case, calculated for minimum and maximum	NBER patent database, Google, and Westlaw
pat_age_first	Age of the oldest patent-at-issue from date of complaint, calculated in days and years	Calculated
pat_age_last	Age of the youngest patent-at-issue from date of complaint, calculated in days and years	Calculated
pat_age_avg	Average age of all the patents-at-issue from date of complaint, calculated in days and years	Calculated
Pat_Claims	Number of claims of all patents-at-issue in the case, calculated for minimum, maximum, average, and total	NBER patent database, Google, and Westlaw
Pat_Fwd_Cite_02	Number of forward citations of all patents-at-issue in the case from the NBER 2002 coding, calculated for minimum, maximum, and average number of forward citations through 2002	NBER patent database, Google, and Westlaw
Pat_Fwd_Cite_10	Number of forward citations of all patents-at-issue in the case not available in the NBER 2002 coding, calculated for minimum, maximum, and average number of forward citations through early 2010	Google and Westlaw
IPC4_Human_Nec	One or more of the patents-at-issue had an IPC code that began with "A" (Human Necessities)	NBER patent database, Google, and Westlaw
IPC4_Perf_Ops	One or more of the patents-at-issue had an IPC code that began with "B" (Performing Operations; Transporting)	NBER patent database, Google, and Westlaw
IPC4_Chem	One or more of the patents-at-issue had an IPC code that began with "C"(Chemistry; Metallurgy)	NBER patent database, Google, and Westlaw
IPC4_Textiles	One or more of the patents-at-issue had an IPC code that began with "D" (Textiles; Paper)	NBER patent database, Google, and Westlaw
IPC4_Construction	One or more of the patents-at-issue had an IPC code that began with "E" (Fixed Constructions)	NBER patent database, Google, and Westlaw
IPC4_Mech_Engineering	One or more of the patents-at-issue had an IPC code that began with "F" (Mechanical Engineering; Lighting; Heating; Weapons; Blasting)	NBER patent database, Google, and Westlaw
IPC4_Physics	One or more of the patents-at-issue had an IPC code that began with "G" (Physics)	NBER patent database, Google, and Westlaw
IPC4_Electricity	One or more of the patents had an IPC code that began with "H" (Electricity)	NBER patent database, Google, and Westlaw
PTO_Main_Class	PTO Main Class Code for patent-in-suit; each individual patent in the case has its own variable	NBER patent database, Google, and Westlaw

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C. Databases and online resources

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Fortune 1000: http://money.cnn.com/magazines/fortune/fortune500/2009/full_list/
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