

# The Layered Patent System

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*ABSTRACT: The patent system is usually described in terms of opposites, like producers versus trolls or software versus pharma. But the reality is a far more complex set of layers, including enforcers, patentees, and technology. This study of 25 years of patent litigation by highly litigious non-practicing entities (“NPEs”) and randomly selected plaintiffs explores each of these layers and shows ways that each interacts with the others, using patent validity as a primary exemplar.*

*Data related to more than 1000 patent outcomes in more than 2000 cases leads to some surprising findings. For example, while the litigious NPEs enforced many patents from product companies and public companies, the patents enforced by random companies were more likely to come from larger and better-funded companies. Additionally, the data implies that patents obtained by individuals fared worse in litigation, regardless of who enforced them. Most surprisingly, once patentee and enforcer type is considered, software patents are no longer a statistically significant predictor of invalidation.*

*The layering of the system shows that simple stories describing one layer at a time cannot answer the questions that face the patent system. The interconnections between the layers of the patent system point the way.*

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## I. INTRODUCTION

As patent reform looms, debate continues between different factions. Our patent system appears divided by technology, both in theory<sup>1</sup> and in practice.<sup>2</sup> Or maybe it is divided by types of inventors and patentees: large, small, and individual.<sup>3</sup> Litigants surely create division, with a variety of

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1. See generally DAN L. BURK & MARK A. LEMLEY, *THE PATENT CRISIS AND HOW THE COURTS CAN SOLVE IT* (2009) (arguing that patent policy should differ for different industries); Christopher M. Holman, *Is Lilly Written Description a Paper Tiger?: A Comprehensive Assessment of the Impact of Eli Lilly and Its Progeny in the Courts and PTO*, 17 *ALB. L.J. SCI. & TECH.* 1 (2007) (discussing generally differing written description and enablement rules in nonmechanical arts); Sean B. Seymore, *Heightened Enablement in the Unpredictable Arts*, 56 *UCLA L. REV.* 127 (2008).

2. See generally John R. Allison, Mark A. Lemley & David L. Schwartz, *Our Divided Patent System*, 82 *U. CHI. L. REV.* 1073 (2015) (presenting data about different litigation outcomes in different industries and technologies).

3. Timo Fischer & Joachim Henkel, *Patent Trolls on Markets for Technology—an Empirical Analysis of NPEs’ Patent Acquisitions*, 41 *RES. POL’Y* 1519, 1520–27 (2012) (examining the source of NPE patents); Michael Risch, *Patent Troll Myths*, 42 *SETON HALL L. REV.* 457, 485 (2012) (same); see also B. Zorina Khan & Kenneth L. Sokoloff, *Institutions and Technological Innovation During Early Economic Growth: Evidence from the Great Inventors of the United States, 1790–1930*, in *INSTITUTIONS, DEVELOPMENT, AND ECONOMIC GROWTH* 123, 140–41 tbl.5.3 (Theo S. Eicher & Cecilia García-Peñalosa eds., 2006) (describing a table showing that a majority of patent holders starting in 1739 sold or licensed their patents); Naomi R. Lamoreaux et al., *Patent Alchemy: The Market for Technology in US History*, 87 *BUS. HIST. REV.* 3, 5 (2013) (“The bulk of the patents came from inventors who exploited their intellectual property by selling off or licensing the rights.”).

acronyms—or worse—used to describe different types of plaintiffs.<sup>4</sup> While these divisions are real, each alone does not capture the layered connections between inventors, enforcers, and technologies. Instead, head-to-head comparisons present themselves in the aggregate, mere snapshots of the bigger picture. Like the proverbial elephant identified by three blind observers, one commentator feels a leg and identifies a technology problem, another feels a tail and finds a litigant problem, and a third feels the trunk and discovers a patentee problem.

This Article uses a novel dataset of 25 years of litigation to examine how these layers form the whole elephant. It begins with enforcement, moves to patentees, and finishes with technology. Finally, it uses statistical modeling to further explore the connections between different layers.

The results reveal a far more complex puzzle than any one dichotomy allows. One must look deeper than patent trolls versus product companies, or information technology versus pharmaceuticals, for explanation. Instead, the story begins with how invention is achieved, who has the resources to complete what types of inventions, and how this affects who eventually enforces patent rights.

For example, the data shows that, litigation tactics aside, the identity of the initial patentee is better correlated with patent invalidation than the identity of the party bringing the suit. It is well known that individual plaintiffs win less often than other plaintiffs. The data presented here suggests that the problem may not be individual plaintiffs, but patents obtained by individuals. The problem seems to dissipate if the inventor is savvy enough to form a company.<sup>5</sup> Patents issued to inventor companies do not fare as poorly, while patents issued directly to the inventor fare worse, regardless of technology. This is a surprising outcome that affects how we should think about individual inventors and their companies, patent plaintiffs, and patent quality.

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4. PRICEWATERHOUSECOOPERS LLP, 2014 PATENT LITIGATION STUDY: AS CASE VOLUME LEAPS, DAMAGES CONTINUE GENERAL DECLINE 1 (2014), [http://www.pwc.com/en\\_US/us/forensic-services/publications/assets/2014-patent-litigation-study.pdf](http://www.pwc.com/en_US/us/forensic-services/publications/assets/2014-patent-litigation-study.pdf) (studying litigation outcomes by plaintiff type); Colleen V. Chien, *Of Trolls, Davids, Goliaths, and Kings: Narratives and Evidence in the Litigation of High-Tech Patents*, 87 N.C. L. REV. 1571 (2009) (describing different patent litigant plaintiff and defendant narratives and pairs and exploring their prevalence); Jay P. Kesan & Gwendolyn G. Ball, *How Are Patent Cases Resolved? An Empirical Examination of the Adjudication and Settlement of Patent Disputes*, 84 WASH. U. L. REV. 237, 258 (2006); Michael J. Mazzeo et al., *Do NPEs Matter? Non-Practicing Entities and Patent Litigation Outcomes*, 9 J. COMPETITION L. & ECON. 879 (2013) (studying litigation outcomes by plaintiff type); Gwendolyn G. Ball & Jay P. Kesan, *Transaction Costs and Trolls: Strategic Behavior by Individual Inventors, Small Firms and Entrepreneurs in Patent Litigation* 14 (U. Ill. Coll. of Law, Research Paper Nos. 08-21 & LE09-005, 2009), <http://ssrn.com/abstract=1337166> (examining case outcomes by litigant size).

5. This is consistent with Ashish Arora et al., *The Acquisition and Commercialization of Invention in American Manufacturing: Incidence and Impact* 13–14 (Nat'l Bureau of Econ. Research, Working Paper No. 20264, 2014), <http://www.nber.org/papers/w20264.pdf> (finding that independent inventor inventions are commercially valuable and most often assigned to small firms).

Further, what appear to be technology differences may instead also be patentee and plaintiff differences. These revelations change how we look at the patent system, because most proposals for change focus on only one layer at a time. It makes no sense to target software patents, for example, when only one type of software application performs worse than the others. The results here again run counter to conventional wisdom: they imply that hardware-specific patents perform worse than general software patents when challenged.

The Article begins with identification of the top layer: two groups that enforce patent rights. The first group includes the ten most litigious non-practicing entities (“NPEs”), which many pejoratively call patent trolls. These highly litigious NPEs from the early 2000s represented the birth of calls for patent reform.<sup>6</sup> Though many of them are no longer litigious because their patents expired, some are still maligned.<sup>7</sup> While most of their lawsuits were filed between 2003 and 2009, every lawsuit was identified, some dating back 25 years.<sup>8</sup>

The second group is a randomly selected group of non-NPE patent cases, roughly matched by year. These average patent plaintiffs, if there is such a thing, can be compared against the most extremely litigious NPE plaintiffs. As a result, any given patent plaintiff generally will fall on a continuum from a product company (shorthand for companies that sell products or services) filing a single patent in a single lawsuit to the most litigious NPE, and may share some characteristics with either type.

This Article then examines who obtained the patents in each group. It turns out that who obtained the patents was often different from who

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6. See, e.g., John Letzing, *Famed Patent Firm Acacia Hits Unwelcome Milestone*, MARKETWATCH (Nov. 16, 2007, 4:57 PM), <http://www.marketwatch.com/story/famed-patent-firm-acacia-hits-unwelcome-milestone> (discussing Acacia’s suits in Texas in the context of reform bills to limit venue choices); John Letzing, *Speculator of Mundane Patents Casts a Long Shadow*, MARKETWATCH (Sept. 7, 2007, 12:38 AM), <http://www.marketwatch.com/story/as-congress-mulls-patent-reform-holding-company-files-more-suits> (discussing Plutus IP lawsuits in context of patent reform).

7. See, e.g., Paul Belleflamme, *What to Think of ‘Patent Trolls’? The Return*, IPDIGIT (Oct. 31, 2011), <http://www.ipdigit.eu/2011/10/what-to-think-of-patent-trolls-the-return> (debating the merits of General Patent Corp. as a troll); Joe Mullin, *Rackspace Sues “Most Notorious Patent Troll in America,”* ARS TECHNICA (Apr. 4, 2013, 10:15 PM), <http://arstechnica.com/tech-policy/2013/04/rackspace-sues-most-notorious-patent-troll-in-america> (claiming wrongful assertion by IPNav); Rik Myslewski, *Survey: Patent Litigation Skyrocketing, Trolls Top 10 Sueball Chuckers*, REGISTER (May 13, 2014, 8:33 PM), [http://www.theregister.co.uk/2014/05/13/survey\\_patent\\_litigation\\_skyrocketing\\_trolls\\_top\\_10\\_sueball\\_chuckers](http://www.theregister.co.uk/2014/05/13/survey_patent_litigation_skyrocketing_trolls_top_10_sueball_chuckers) (showing Ronald A. Katz Technology Licensing in top ten list for most patents involved in lawsuits); Bill Rigby, *Microsoft Sues Acacia over Smartphone Patents*, REUTERS (Nov. 20, 2013, 2:50 PM), <http://www.reuters.com/article/us-microsoft-patents-idUSBRE9AJ14X20131120> (“Acacia’s lawsuits are the worst kind of abusive litigation behavior, attempting to extract payment based on litigation tactics and not the value of its patents.” (quoting an industry lawyer)); David Segal, *Has Patent, Will Sue: An Alert to Corporate America*, N.Y. TIMES (July 13, 2013), <http://www.nytimes.com/2013/07/14/business/has-patent-will-sue-an-alert-to-corporate-america.html> (profiling Erich Spangenberg and IPNav).

8. The dataset ends with cases filed on December 31, 2009.

enforced the patents in both groups. The groups had some unexpected similarities and some unexpected differences. The patents in both groups—even the litigious NPEs—were obtained in large part by product companies, companies engaged in invention to make and sell products or services. However, the NPE group included a much higher percentage of patents issued to small companies and individual inventors. This illustrates a connection between layers. There appears to be two separate tracks of patentees: large, well-funded companies versus individuals and small companies. While both tracks are represented in each group, the litigious NPEs were much more likely to enforce the patents of smaller patentees than the average litigant.

This Article next considers an additional layer: patented technology. Using three different measures—technology class, art unit, and software—it becomes clear that the litigious NPEs often assert different technology than the average patent litigant. These NPEs assert more electronics, computer, and communications patents, more software patents, and virtually no therapeutic patents. These differences might be explained in a couple of ways. Highly litigious NPEs may focus on these types of patents because they are easier to assert, more malleable,<sup>9</sup> or otherwise better suited to repetitive litigation. This current explanation is surely apt, but it is incomplete. If there were money to be made through litigation in chemical patents, rational NPEs would pursue it. Indeed, the non-NPE group includes Monsanto, an extraordinarily litigious plaintiff that has had great success and has also assigned its patents to a subsidiary licensing and enforcement corporation—a wholly owned NPE.<sup>10</sup> The technology asserted by litigious NPEs is in part determined by the patentees from which they draw their patents. High technology inventions may be easier to develop and obtain for individuals and small companies. Because those patentees later turn to litigious NPEs to assert these patents, litigious NPEs are more likely to assert particular technologies. More costly patents, on the other hand, are more likely to be associated with firm research and development, and thus more likely to be asserted by that firm.

Identifying the layers is an important step forward, allowing for much more nuanced analysis of patents and litigation. For example, to the extent that NPEs are justified as creating a market for patents and technology,<sup>11</sup> it appears that certain types of patentees and/or technologies benefit most from

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9. See generally Jason Rantanen, *The Malleability of Patent Rights*, 2015 MICH. ST. L. REV. 895.

10. This is an IP-licensing arm of a product company, rather than a “privateer,” a third-party enforcer of patents.

11. Julien Pénin, *Strategic Uses of Patents in Markets for Technology: A Story of Fabless Firms, Brokers and Trolls*, 84 J. ECON. BEHAV. & ORG. 633, 634–35 (2012) (describing benefits of patent brokers that disseminate technology); see also James F. McDonough III, Note, *The Myth of the Patent Troll: An Alternative View of the Function of Patent Dealers in an Idea Economy*, 56 EMORY L.J. 189, 209–11 (2006) (describing NPEs as market-makers).

such a market.<sup>12</sup> Examinations of patent markets should consider these differences.

This Article attempts to tease out the role of each layer on patent quality. Part II provides a brief overview of the divisions in the patent system and introduces reasons why focus on each particular layer may not provide sufficient policy information. Parts III, IV, and V provide data about each layer, beginning with enforcers, moving to patentees, and ending with technology. Each part provides basic information about each layer, as well as patent validity outcome data which combines layers. Part VI presents the results of logistic regressions that illustrate the complexity of the interactions between layers. It shows that no one category explains why a patent might be invalidated and that seemingly explanatory variables become less explanatory when other layers are added to the analysis. Part VII concludes by calling for reassessment of the patent troll narrative based on the layered patent system.

## II. THE CONVENTIONAL NARRATIVE: ONE LIMB AT A TIME

There is no shortage of commentary on the patent system, but most analysis is limited to dueling propositions. Articles pit productive companies versus patent trolls.<sup>13</sup> Indeed, the troll rhetoric has driven the call for patent reform at the highest levels of government.<sup>14</sup> It is not surprising that so many studies focus on litigant identity. First, it is one of the most observable attributes of any lawsuit. Second, the plaintiff brings suit, and thus is the party most responsible for the lawsuit.<sup>15</sup>

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12. Robin Feldman & W. Nicholson Price II, *Patent Trolling: Why Bio & Pharmaceuticals Are at Risk*, 17 STAN. TECH. L. REV. 773, 788 (2014) (“Barriers to entry are low enough that it is easier and cheaper than ever for small companies to enter the market and create apps without substantial investment.”); *see also id.* at 789 (“[T]he difficulty of entering the bio/pharmaceutical product market suggests that there will be fewer patents floating around that monetizers can acquire and fewer targets for them to go after.”).

13. *See, e.g.*, Markus Reitzig et al., *On Sharks, Trolls, and Their Patent Prey—Unrealistic Damage Awards and Firms’ Strategies of “Being Infringed,”* 36 RES. POL’Y 134, 144 (2007) (modeling litigant behavior). Only recently have empirical studies actually compared NPE outcomes directly to product company outcomes. Robin Feldman et al., *The AIA 500 Expanded: The Effects of Patent Monetization Entities*, 17 UCLA J.L. & TECH. 1, 59–62 (2013) (summarizing the outcomes of randomly selected cases). *See generally* John R. Allison, Mark A. Lemley & Joshua Walker, *Patent Quality and Settlement Among Repeat Patent Litigants*, 99 GEO. L.J. 677 (2011) (analyzing outcomes of the most litigated patents, many of which were NPE patents); Shawn P. Miller, *Where’s the Innovation: An Analysis of the Quantity and Qualities of Anticipated and Obvious Patents*, 18 VA. J.L. & TECH. 1, 6 (2013) (considering the obviousness and anticipation of NPEs and productive companies); Michael Risch, *A Generation of Patent Litigation*, 52 SAN DIEGO L. REV. 67 (2015) (comparing detailed invalidity and infringement outcomes over 25 years).

14. Erin Mershon, *Obama Backs Patent Reform Effort in State of the Union*, POLITICO: POLITICO NOW BLOG (Jan. 28, 2014, 9:21 PM), <http://www.politico.com/blogs/politico-live/2014/01/obama-backs-patent-reform-effort-in-state-of-the-union-182139.html>.

15. Of course, this is a simplification. Some patent owners are defendants in declaratory relief actions, and some may bring suit in order to protect licensees.

However, patent litigants are not solely responsible for the patents they assert. Someone else initially owned many litigated patents. Inventors must always apply for patents in their own names. They can, however, assign their patent to a company or another person at any time. If they do so before a deadline set by the Patent and Trademark Office (“PTO”), that assignee is shown on the face of the patent and is called an initial assignee. Some accounts have focused on initial owners of patents in the aggregate<sup>16</sup> and as case studies<sup>17</sup> and in surveys.<sup>18</sup> These accounts are helpful for understanding why certain patents are asserted. Were they acquired from another prior to lawsuit? Were they asserted by the companies that developed them?<sup>19</sup> The assignee type may even forecast the technologies involved.

Still more accounts of the patent system focus on the patented technology. Commentators compare differential treatment of different technologies<sup>20</sup> as well as differentials in litigation outcomes by technology.<sup>21</sup> A few studies combine technology and NPEs.<sup>22</sup> Further, technology may make

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16. See, e.g., Fischer & Henkel, *supra* note 3 (examining acquisitions of NPE patents); Michael Risch, *supra* note 3 (same).

17. See, e.g., Kristen Osenga, *Formerly Manufacturing Entities: Piercing the “Patent Troll” Rhetoric*, 47 CONN. L. REV. 435 (2014) (examining NPEs that previously created and sold products); Ashley Chuang, Note, *Fixing the Failures of Software Patent Protection: Deterring Patent Trolling by Applying Industry-Specific Patentability Standards*, 16 S. CAL. INTERDISC. L.J. 215, 221–27 (2006) (describing different NPE sources).

18. Stuart J.H. Graham et al., *High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey*, 24 BERKELEY TECH. L.J. 1255, 1274–75 (2009) (surveying sources of patents held by entrepreneurial firms); Theresa Veer & Florian Jell, *Contributing to Markets for Technology? A Comparison of Patent Filing Motives of Individual Inventors, Small Companies and Universities*, 32 TECHNOVATION 513, 514 (2012) (reporting survey findings that individuals are more likely to patent in order to block others for ex post enforcement).

19. Joe Mullin, *How Operating Companies Can Stop Patent Trolls: Cut Off the Ammo*, ARS TECHNICA (July 9, 2014, 4:40 PM), <http://arstechnica.com/tech-policy/2014/07/how-operating-companies-can-stop-patent-trolls-cut-off-the-ammo> (arguing that NPE litigation can be diminished if no one sells patents to NPEs).

20. BURK & LEMLEY, *supra* note 1.

21. Allison, Lemley & Schwartz, *supra* note 2 (examining outcomes based on technology); Alberto Galasso & Mark Schankerman, *Patent Thickets, Courts, and the Market for Innovation*, 41 RAND J. ECON. 472, 485–86 (2010) (modeling duration by technology); Axel Haus & Steffen Juranek, *Patent Trolls, Litigation, and the Market for Innovation* 9–10 (Dep’t of Bus. & Mgmt. Sci., Norwegian Sch. of Econ., Discussion Paper No. 24, 2014), <http://brage.bibsys.no/xmlui/bitstream/handle/11250/217631/1/DiscussionPaper.pdf> (examining case duration considering patent technology and defendant patenting intensity).

22. See, e.g., Brian J. Love, *An Empirical Study of Patent Litigation Timing: Could a Patent Term Reduction Decimate Trolls Without Harming Innovators?*, 161 U. PA. L. REV. 1309, 1343–44 (2013) (examining patent technologies asserted by different types of plaintiffs but not including outcomes).

a difference in optimal licensing rates<sup>23</sup> or litigation outcomes.<sup>24</sup> Others look at patenting and entry rates based on legal changes affecting that technology<sup>25</sup> or differential patenting<sup>26</sup> and litigation<sup>27</sup> rates by type of technology.

These accounts are intuitive—compelling even—but incomplete. At the very least, an important temporal aspect is lost: patent applications are often filed years before litigation and often change hands in the meantime.<sup>28</sup> A consideration of just litigants or just initial assignees cannot explain what happened in between. Indeed, a focus on litigation at the expense of the underlying patentees and their technology may miss important details about who produces different types of inventions.<sup>29</sup> For example, NPE litigation in 2009 asserted patent applications filed at the birth of the World Wide Web in the early 1990s. Thus, every patent case is as much about the plaintiff as it is about the original patentee, and both are informed by how technology changed during the time from application to assertion.

The nature of research and development has shifted over time. Individual and small inventors became less important in the patent system around the turn of the 20th century.<sup>30</sup> This shift coincided with the growth of large firm inventing and patenting.<sup>31</sup> For much of the 20th century, assertion of acquired patents diminished as inventors joined companies and assigned

23. Rubén Hernández-Murillo & Gerard Llobet, *Patent Licensing Revisited: Heterogeneous Firms and Product Differentiation*, 24 INT'L J. INDUS. ORG. 149, 168 (2006) (“Our model illustrates the different trade-offs in the choice of licensing contracts that the patentholder faces, and how they are affected by changes in the degree of differentiation in the downstream market.”).

24. Miller, *supra* note 13, at 46–48 (estimating outcomes based on technology); see also Alan C. Marco, *The Selection Effects (and Lack Thereof) in Patent Litigation: Evidence from Trials*, 4 TOPICS ECON. ANALYSIS & POL'Y 1, 17 (2004) (estimating outcomes using broad technology categories).

25. Iain M. Cockburn & Megan J. MacGarvie, *Entry and Patenting in the Software Industry*, 57 MGMT. SCI. 915, 915 (2011).

26. Stuart Graham & Saurabh Vishnubhakat, *Of Smart Phone Wars and Software Patents*, 27 J. ECON. PERSP. 67, 77–79 (2013) (examining PTO allowance rates for software and nonsoftware).

27. JAMES BESSEN & MICHAEL J. MEURER, PATENT FAILURE: HOW JUDGES, BUREAUCRATS, AND LAWYERS PUT INNOVATORS AT RISK 187–93 (2008) (describing the problems associated with software patents, including high rates of litigation and claim-construction review); Shine Tu, *Patent Examiners and Litigation Outcomes*, 17 STAN. TECH. L. REV. 507, 538–41 (2014) (showing litigation rates by different technology groups).

28. Feldman et al., *supra* note 13, at 68 (finding more than half of patents assigned prior to suit); Love, *supra* note 22, at 1339 (showing age of patents by litigant type).

29. See, e.g., Colleen V. Chien, *Patent Amicus Briefs: What the Courts' Friends Can Teach Us About the Patent System*, 1 U.C. IRVINE L. REV. 395, 422–23 (2011) (showing that patentee type may be as important as technology type in amicus brief filings).

30. Lamoreaux et al., *supra* note 3, at 34 n.99. See generally Naomi R. Lamoreaux et al., *The Reorganization of Inventive Activity in the United States During the Early Twentieth Century*, in UNDERSTANDING LONG-RUN ECONOMIC GROWTH: GEOGRAPHY, INSTITUTIONS, AND THE KNOWLEDGE ECONOMY 235 (Dora L. Costa & Naomi R. Lamoreaux eds., 2011).

31. Lamoreaux et al., *supra* note 3, at 34.

their patents to those companies.<sup>32</sup> As corporate research grew (and inventions became more expensive), small and independent patenting and licensing shrank in number and importance.<sup>33</sup>

Today, large companies have limited their investments in research and development such that they are a much smaller portion of their overall spending.<sup>34</sup> Indeed, many large companies have assigned some of their patents to others for licensing, rather than holding them within the firm.<sup>35</sup> Furthermore, software has allowed many more small and independent inventors to obtain patents.<sup>36</sup>

However, small and independent inventors may not be best situated to commercialize or enforce their patents. Instead, NPEs may better enforce patents on behalf of particular inventors or even in particular technologies.<sup>37</sup>

Thus, each explanation falls short. A deep understanding of any one layer will fail to answer all of the policy questions that arise. More importantly,

32. Michael Risch, *Licensing Acquired Patents*, 21 GEO. MASON L. REV. 979, 998 (2014) (“Thus, acquired patents may follow the ebb and flow of small and independent inventors.”).

33. JUSTIN E. GRAY & HAROLD C. WEGNER, FOLEY & LARDNER LLP, TOP 150 “CUSTOMERS”: INCREASING DOMINATION OF THE PATENT SYSTEM 3 (2009), <http://www.grayonclaims.com/storage/GrayWegnerTop300Nov23REV.pdf> (noting the concentration of patents in large companies); Robert P. Merges, *One Hundred Years of Solicitude: Intellectual Property Law, 1900–2000*, 88 CALIF. L. REV. 2187, 2216 (2000) (“As the twentieth century progressed, inventions were more and more likely to be the product of large-scale corporate R&D rather than of the lone workshop tinkerer.”).

34. Ashish Arora & Alfonso Gambardella, *The Market for Technology*, in 1 HANDBOOK OF THE ECONOMICS OF INNOVATION 641, 651–52 (Bronwyn H. Hall & Nathan Rosenberg eds., 2010); Lamoreaux, *supra* note 3, at 34 (“In the face of stepped-up competition, large firms began to cut their research budgets and acquire more of their technology from outside sources. In the process, their share of nonfederal R&D expenditures dropped from about two-thirds in 1980 to only about one-third in 2005.”); *see also* Charles Duhigg & Steve Lohr, *The Patent, Used as a Sword*, N.Y. TIMES (Oct. 7, 2012), <http://www.nytimes.com/2012/10/08/technology/patent-wars-among-tech-giants-can-stifle-competition.html> (“Last year, for the first time, spending by Apple and Google on patent lawsuits and unusually big-dollar patent purchases exceeded spending on research and development of new products, according to public filings.”); Jon Gertner, *Like Building Refrigerators: Bell Labs and the End of Game-Changing Innovation*, TIME (Mar. 27, 2012), <http://business.time.com/2012/03/27/like-building-refrigerators-bell-labs-and-the-end-of-game-changing-innovation> (stating about the closing of Bell Labs that “it had become difficult, and perhaps unnecessary, for a company to capture the value of a big breakthrough. So why do it?”).

35. *See* Leslie A. Gordon, *Patent Privateers’ Do Legal Legwork for Big-Time Tech Companies*, A.B.A. J. (July 1, 2013, 8:30 AM), [http://www.abajournal.com/magazine/article/small\\_companies\\_pick\\_up\\_the\\_cost\\_of\\_patent\\_privateering\\_litigation](http://www.abajournal.com/magazine/article/small_companies_pick_up_the_cost_of_patent_privateering_litigation).

36. *See* Lamoreaux et al., *supra* note 3, at 36; *see also id.* at 34 (“By the end of the [20th] century, however, small firms and independent inventors were once again major participants in the market.”).

37. Alberto Galasso et al., *Trading and Enforcing Patent Rights*, 44 RAND J. ECON. 275, 299 (2013) (“[C]omparative advantage in patent enforcement may be more important than comparative advantage in commercialization, at least for transfers involving individually owned patents. Second, the results show that patents with larger estimated (enforcement) gains from trade are in fact those with the highest predicted likelihood of changing ownership.”); Mazzeo et al., *supra* note 4, at 889 (noting that NPEs have better outcomes than individuals).

no two layers alone provide a sufficient explanation either. True understanding requires understanding all of the layers. The goal of this Article is to observe how the three layers work together and open the discussion to integrating additional layers in the future.

### III. THE TAIL: ENFORCERS

This Article expands on the data collected for two previous articles: *Patent Troll Myths*,<sup>38</sup> and *A Generation of Patent Litigation*.<sup>39</sup> Those studies focused on enforcers: plaintiffs in patent cases. A brief summary of the data collected follows, and the prior articles detail collection methodologies.

#### A. SUMMARY OF CASES AND PATENT IDENTIFICATION

Data collection began with identification of every case involving the most litigious NPEs of the 2000–2009 time period.<sup>40</sup> While most litigation occurred after 2000, many cases predated 2000. Once these cases were identified, random patent litigation roughly matched by year of lawsuit were collected. From there, the patents involved in each of the cases were identified, as discussed below.

An important aspect of the selection is that every case involving the studied patents in each group was identified and studied. Thus, the entire life cycle of each patent (through 2009) is part of the study. Almost by definition, in most cross-sectional studies only the patents asserted in a given year are studied, and earlier cases involving the same patents are usually lost. We also recorded every outcome of every case, whether or not a ruling on the merits occurred.<sup>41</sup>

We then collected additional data about the NPE and the random control set of cases and patents. This included litigation data such as filing dates, duration, number of defendants,<sup>42</sup> outcomes, and appeals. It also included patent data, including priority date, number of claims, number of continuations, reexaminations, assignments, and number of references cited. We then determined the parties that obtained each patent—the initial assignees.<sup>43</sup> Once initial assignees were identified, we collected information about them.

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38. Risch, *supra* note 3.

39. Risch, *supra* note 13.

40. The plaintiffs were Acacia Research, Plutus IP (now IPNav), Ronald A. Katz Licensing, Catch Curve, General Patent Corp, F&G Research, Millenium, Cygnus Systems, Papst Licensing, and Rates Technology. *Id.* at 77 n.36. For further detail on the data collection process and representation in the matching set, see *id.* at 77–92.

41. Throughout, “we” refers to the author and several research assistants.

42. We did not collect detailed data about defendants because so many cases had multiple defendants—as many as 100 in some cases.

43. Some patents may have been assigned to others shortly after their issuance, but we do not consider such conveyances to be initial assignments here.

First, we gathered objective data available in Hoovers, Dun & Bradstreet's Million Dollar Database, and other publicly available sources. Objective data includes number of employees, revenues, and industry codes. Data was not available for all companies for all fields, and missing data was dropped from relevant analytical analysis.<sup>44</sup>

Second, we gathered publicly available information about companies from a variety of sources, including the Securities and Exchange Commission ("SEC"), press releases, financial web sites that mentioned companies, and Wharton's WRDS database. This data includes date of initial public offering, market value at the time of patent filing, and various dummy variables relating to the relationship of the company's public status and the patent.

Third, we gathered venture capital investment data using Thomson's VentureXpert database. The analysis here assumes that absence from that database indicates no venture funding for the company. This, of course, may not be true, but Thomson tracks millions of venture-backed companies and virtually all of the largest venture funds, such that most venture-backed companies would appear in the database.<sup>45</sup> However, missing venture funding information is a limitation of the data. The VentureXpert data includes the number of investment rounds, the amount invested, the date of first investment, and public offering/acquisition data.

The resulting data set yielded 917 unique litigations in the litigious NPE group, which were consolidated by the court into 752 final actions. The NPE cases involved 352 patents. In turn, the 352 patents resulted from 176 initial patent applications, many of which spawned multiple patents (the max was 41 patents from one application).

The non-NPE group included 1311 unique cases, which were consolidated into 1152 final actions. The cases involved 791 patents stemming from 536 applications (the max was nine from one application).

#### B. SELECTION EFFECTS

A second elephant in the room of this endeavor to see the whole elephant is the selection effect. The question is what a study of the most litigious enforcers tells us about the system as a whole. The best design for a study, of course, would be to examine every case ever brought.<sup>46</sup> Indeed, there are studies of every case and every patentee, and they are valuable studies. Those

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44. For a variety of reasons, one would expect missing data in Dun & Bradstreet to skew available data toward operating companies.

45. There is no reason to believe that there is a selection bias though it is theoretically possible that the types of venture capital companies that would invest in the types of assignees here are the same types that would be excluded from VentureXpert. For further discussion of VentureXpert, see Ronald J. Mann & Thomas W. Sager, *Patents, Venture Capital, and Software Start-Ups*, 36 RES. POL'Y 193, 195 (2007).

46. Even this is not enough, really, because it misses the effects of patents that are not litigated. This is a selection problem present in every study of patent litigation.

studies require so much data collection that they are cross-sectional; they only measure the cases filed in a given set of years, or they only gather minimal data for multiple years.

This study, on the other hand, considers every patent brought by particular entities, no matter when, and studies every single case in which the patent was asserted. One could expand a study of every litigation filed in a given year to include all other cases involving the same patents or parties, but it would be an exceptionally time-consuming task. This study's emphasis on a particular class of patent plaintiff allows for a deep dive into the cases and patents at the expense of breadth.

Another alternate design would be to study random NPEs, but this effort would not be without difficulty. One would first have to define NPEs, and there is a significant disagreement about which plaintiffs should count.<sup>47</sup> No matter the definition, the study would be attacked as over- or underinclusive of the proper parties. Further, given that many NPEs are subsidiaries and shell companies, it would be difficult to discern whether the random firm was part of a larger entity or standing on its own. This is not to say that a random design would fail, only that it is not a panacea.

This study took a different tack. It started with entities that were generally regarded as having a patent enforcement model. These parties also asserted enough patents over a long enough period of time to allow for longitudinal statistical study. Further, these entities were large enough that data could be gathered about them in the news. Finally, they are bookend exemplars, a benchmark against which every other plaintiff might be compared. If these NPEs are imposing the largest social cost, then the validity of their patents is worth studying.

In some ways, these plaintiffs are outliers when compared to NPE plaintiffs generally. There was only one jury verdict in favor of a studied plaintiff, while all NPEs win more than that. In that sense, this group really is a bookend. Because NPEs in general have better outcomes than no wins,<sup>48</sup> the average NPE can be expected to have outcomes about the same as these NPEs or better. Thus, we would expect any random NPE patent to do at least as well as the patents studied here. This means the results presented are the outer bounds of the differences between enforcer types.

But even as an outer limit, there are other ways in which highly litigious NPEs may be representative. There is no reason to believe that the patents are somehow different from any similar NPE patent.<sup>49</sup> The NPEs studied obtain

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47. Michael Risch, *Framing the Patent Troll Debate*, 24 EXPERT OPINION ON THERAPEUTIC PATENTS 127, 127 (2014) (describing different definitions of NPE).

48. See PRICEWATERHOUSECOOPERS LLP, *supra* note 4, at 11.

49. See Michael Risch, *A Patent Behemoth Rears Its Head*, MADISONIAN.NET (Dec. 8, 2010), <http://madisonian.net/2010/12/08/a-patent-behemoth-rears-its-head> (arguing that Intellectual Ventures' patents have characteristics similar to the patents in this study, such as the fact that they are coming from individual inventors, start-ups, and large corporations).

their patents using a similar method used by other NPEs. Those selected represent aggregators, inventor-owned companies, and privateering.<sup>50</sup>

### C. ENFORCER OUTCOMES

The patent plaintiffs, standing alone, are relatively straightforward. The non-NPE set is comprised of a varied group, including individuals, individually owned companies, small companies, and large companies. More than 92% of the non-NPE plaintiffs were product companies, with another 5.7% as individual or individual-owned companies, and the remainder distributed among the other groups. For obvious reasons, the highly litigious NPE set is more circumscribed, falling mostly into the acquired-licensor, inventor-owned, and IP-licensing affiliate of product company groups.<sup>51</sup>

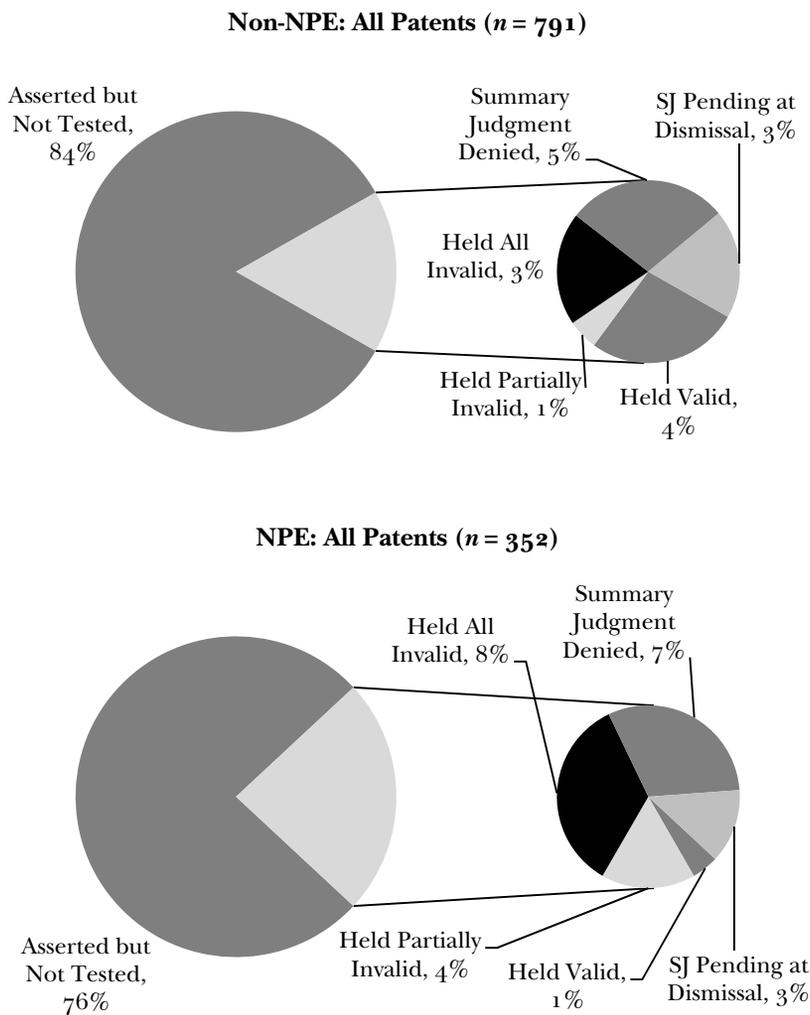
Figure 1 highlights differences in patent quality (invalidity) outcomes based solely on the type of litigant. The chart reports all outcomes, including challenges denied or pending at dismissal. In this chart and all others in this Article, a denial of summary judgment, followed by a later invalidation at trial, is considered an invalidation; the interim denial is not counted.

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50. Privateers enforce a practicing company's patents. See Susan Decker, *Patent Privateers Sail the Legal Waters Against Apple, Google*, BLOOMBERG BUS. (Jan. 10, 2013, 11:00 PM), <http://www.bloomberg.com/news/articles/2013-01-11/patent-privateers-sail-the-legal-waters-against-apple-google>.

51. Risch, *supra* note 13, at 69, 78.

Figure 1. Differences in Patent Quality by Type of Litigant



When considered as a percentage of those patents actually adjudicated, the NPE patents performed on the whole more poorly than non-NPE patents. When challenged, some or all of the claims were invalidated slightly more than 50% of the time, compared to 25% for non-NPEs. The summary judgment attempts to invalidate were denied at about the same rates, around 30%. Interestingly, the non-NPE group had a higher dismissal rate with summary judgment challenges pending (19%) than the NPEs (13%). This is contrary to a view that these litigious NPEs dismiss rather than see their patents challenged at a rate different from other plaintiffs.

The primary difference between the two groups appears to be the much higher percentage of patents found valid among non-NPEs, a phenomenon discussed in a prior article.<sup>52</sup> In the end, about 12% of the NPE patents asserted over 25 years were invalidated either partially or completely. These invalidations came in about 3% of the cases, because most cases involved multiple invalid patents. The remainder of patents and cases either went untested or survived pretrial challenge.

Finally, the primary factors that correlated with invalidation related not to NPE status or patent quality metrics (like number of claims or forward citations) but to choices litigants made such as how many defendants to sue, how often the patent was asserted, and whether to sue in a district that would lead to a transfer.<sup>53</sup> Statistical analysis in Part VI combines these selection factors with information about patentees and technology discussed in the next two Parts.

This Article focuses on invalidity findings, rather than infringement findings. Prior work considers differential infringement findings among enforcers,<sup>54</sup> finding generally that infringement is a more common reason for plaintiffs of all kinds to lose, and also that NPEs were more likely to lose on noninfringement grounds. This Article does not consider infringement findings, because enforcers have much more control over the defendants they sue than they do over the reasons a patent may be invalid.

#### IV. THE TRUNK: PATENTEES

An analysis of the source of patents asserted by NPEs and non-NPEs shows a channeling of innovative efforts based in large part on company size and success. The NPE group asserted many more patents obtained by individuals than the non-NPE group. Further, there were some differences among companies that obtained patents. These findings reinforce a key finding of *Patent Troll Myths*: how one views these litigious NPEs should depend in large part on how one views the underlying inventive efforts.

In both groups, the final plaintiff was quite often different than the initial patentee. The non-NPE group members were more likely to hold on to their patents, though many of the non-NPE patents were assigned. A total of 531 of the non-NPE patents, or 67%, had at least one conveyance. The NPE group saw 310 conveyances, or 88% of the patents.

Among the non-NPE group, patents were assigned an average of 1.57 times after the initial assignment, with a median of one and standard deviation of 1.7. The litigious NPE group's patents were assigned an average of 2.77 times, with a median of two and standard deviation of 2.5. The maximum number of assignments was ten for non-NPEs and 13 for NPEs.

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52. See generally *id.*

53. See *id.* at 106–24.

54. See *id.* at 124–31.

But who were the original patentees? The following table identifies who originally obtained the patents in this study. We classified each initial assignee according to type of business. The classifications follow those of prior studies,<sup>55</sup> classifying patent owners into a variety of different patent business models. The classifications here differ from other studies of patent plaintiffs, however, because they relate to the business of the owner *at the time of patenting*. Of course, every patent asserted by the litigious NPE group was owned either by an acquiring licensing company, an individually owned company, or an IP subsidiary of a product company at the time of assertion. At the time of patenting, however, different types of entities owned the patents.

Table 1. Original Patent Assignees by Patent Business Model at the Time of Patenting

Category	Assignee Type	Non-NPE	NPE
1	Acquired Patents/Licensing	0.13%	8.24%
3	Failed Startup	0.76%	1.99%
4	Former Product Co.	0.63%	0.00%
5	Individual Inventor Co. <sup>56</sup>	3.92%	14.20%
6	Univ./Gov't/NGO	2.53%	1.14%
7	Startup—Preproduct	0.00%	1.42%
8	Product Co.	74.21%	42.90%
9	Individual	16.06%	29.26%
10	Undetermined	0.25%	0.00%
12	IP Sub. of Product Co.	1.52%	0.85%
<b>Total</b>		<b>100.00%</b>	<b>100.00%</b>

The data shows that product companies are the most used source of patents for both groups, but much more so for the non-NPEs (74% for non-NPEs and 43% for NPEs). Further, patents assigned to individuals and their companies were disproportionately represented in the NPE group, with a total of about 20% for non-NPEs and 43% for NPEs. The other categories are negligible, meaning that the primary division between these two groups is

55. See, e.g., John R. Allison, Mark A. Lemley & Joshua Walker, *Extreme Value or Trolls on Top? The Characteristics of the Most-Litigated Patents*, 158 U. PA. L. REV. 1, 10 (2009) (categorizing plaintiffs according to Lemley/Myhrvold company schema); Risch, *supra* note 3, at 495–96 (categorizing patent owners by the same categories).

56. Category 5 includes companies formed by a patent's inventor for the purpose of research and development or licensing. Individually owned companies that sell products or services are in category 8 (or sometimes one of the others).

product companies and individuals even though product companies are well represented among the NPE group.

The nonindividual entities are dominated by companies—more than 98% in each group. The remaining 2% are divided between universities and hospitals; the NPE group has a greater proportion of hospitals, while the non-NPE group has more universities. In the NPE group, about 32% of the initial company assignees were principally dedicated to licensing and enforcement, while only two non-NPE assignees were dedicated to enforcement at the time the patent issued. This is not surprising, given that licensing companies were expressly excluded from the non-NPE group.

The following table compares the companies that initially obtained the patents asserted by each group—colloquially, the patentees.<sup>57</sup> These comparisons are not based on the time of patenting. Instead, they consider whether the companies were ever public, ever ceased operations, ever acquired, or ever venture funded.<sup>58</sup> Further, the companies are counted by patent, so the same company obtaining two patents will appear twice. Thus 86% (650/752) of the non-NPE patents were obtained by companies while 70% (248/352) of the NPE patents were obtained by companies.

These comparisons are helpful to assess both the inventive activities of the company as well as the provenance of patents asserted in litigation. The table also includes data on Patent Office entity size, showing both individuals and the number of entities reporting fewer than 500 employees.

Table 2. Types of Companies That Initially Obtained Patents

Company Status	Non-NPE	NPE
<b>Total Companies</b> <sup>59</sup>	650	248
Public	38.00%	15.32%
Public Subsidiary	13.54%	6.85%
Venture Funded	21.08%	14.92%
PTO Small Entity <sup>60</sup>	40.75%	54.73%
Defunct <sup>61</sup>	13.99%	10.30%
Acquired	23.08%	26.21%

57. The inventor was always the actual patentee, but the initial assignee provides information about the circumstances relating to the patent.

58. Overlaps in the public/public subsidiary were removed (55 in the non-NPE group and nine in the NPE group). Overlaps in venture-funded companies were not removed.

59. All differences are statistically significant at  $p = 0.000$  in a  $t$ -test.

60. Counts are much higher; virtually every patent had an entity size code.

61. About 20 patents were excluded from the calculation because current status of the initial assignee could not be determined.

The differences in funding type were relatively stark and statistically significant. The non-NPE group asserted more than twice as many patents acquired by public or public subsidiary companies—52% to 22%. Further, the non-NPE patents were obtained by venture-funded companies about 50% more often. The percentage of companies that were defunct or acquired was not statistically significant, which is consistent with previous findings that these NPEs did not provide a special advantage to liquidating companies.<sup>62</sup>

As the following table shows, the market value of public companies and the amount of venture funding, sales, and employees was higher among companies obtaining patents in the non-NPE group.

Table 3. Market Value of Companies Obtaining Patents

Non-NPE*	<i>n</i>	Mean	Med	Min	Max	StDev
Market Value at Filing	160	\$16,132	\$3053	\$11	\$270,847	\$37,638
Venture Funding	100	\$107	\$28	\$1	\$1463	\$317
Sales	458	\$12,058	\$147	\$0.044	\$147,359	\$26,721
Employees	490	26,372	682	1	434,246	70,552

\*all \$ in millions

NPE*	<i>n</i>	Mean	Med	Min	Max	StDev
Market Value at Filing	14	\$7418	\$1942	\$102	\$62,034	\$16,077
Venture Funding	37	\$20	\$7.5	\$0.5	\$72	\$21
Sales	78	\$3576	\$1.5	\$0.11	\$79,029	\$12,057
Employees	149	4674	13	4	172,438	20,575

\*all \$ in millions

The comparison shows real and significant differences in every measure. Though highly skewed for both groups, companies obtaining the non-NPE patents had more employees, more sales, more venture funding, and more market value at every percentile.<sup>63</sup> Further, the medians show that half of the companies obtaining NPE patents remained very small, with 13 or fewer employees among those for which data was available.<sup>64</sup> The percentage of

62. For extensive discussion of this issue, see Risch, *supra* note 3, at 491–93.

63. Interestingly, the place of incorporation does not show marked differences. More of the NPE corporations were incorporated in Delaware (28% to 34%) and in foreign countries (21% to 27%). One would have expected more corporations incorporated in Delaware among the non-NPEs given the other differences, but this does not hold true. At the very least, it implies that place of incorporation may not be a good proxy for public or venture funding.

64. Compare Gerard N. Magliocca, *Blackberries and Barnyards: Patent Trolls and the Perils of Innovation*, 82 NOTRE DAME L. REV. 1809, 1831 (2007) (theorizing that NPEs thrive when patent

companies for which data was available was smaller among the litigious NPE group, which also implies smaller companies, because smaller companies are less likely to file forms with the SEC, get listed in a business database, or have a website in the early days of the Internet

Even so, these results should not be overstated. More than 20% of the companies obtaining patents asserted by the highly litigious NPEs were public, and 15% of them were venture funded. Nonetheless, the data supports a conclusion that the companies obtaining non-NPE patents are bigger, better funded, and more likely to be selling products than the companies obtaining patents asserted by these highly litigious NPEs. This conclusion is fortified by the higher percentage of individual inventor-obtained patents in the NPE group. Whether this conclusion holds true for all NPEs depends on the extent that these litigious NPEs found their patents from similar companies as other NPEs. This is unlikely to be true for universities and research and development companies like InterDigital but may hold for individual-owned companies and patent-licensing firms.

Finally, the effect of these differences depends on how one views the importance of invention by individuals and companies that are less well-funded, sell less, and have fewer employees. As discussed in Part VI, individual inventor patents are more likely to be invalidated. Even so, only a small fraction of them reach that point. If one believes that such entities contribute valuable inventions to society, then the litigious NPEs may be vindicating socially beneficial incentives. If one believes that such entities do not provide a social benefit through patenting, then this evidence will only bolster that view.

## V. THE LEGS: TECHNOLOGY

It is relatively well-documented that NPEs tend to assert patents in areas different than the general litigating population.<sup>65</sup> This study shows a disparity over a period of 25 years for highly litigious NPEs. With the assertion of different types of patents come different problems, most notably with respect to patent defects.

Observers dispute the reasons why NPEs assert different types of patents, with many arguing that NPEs prefer vague software patents. However, as

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acquisition costs are low), with Jean O. Lanjouw & Mark Schankerman, *Protecting Intellectual Property Rights: Are Small Firms Handicapped?*, 47 J.L. & ECON. 45 (2004) (analyzing whether small inventors are at a significant disadvantage in enforcement).

65. See, e.g., U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-13-465, INTELLECTUAL PROPERTY: ASSESSING FACTORS THAT AFFECT PATENT INFRINGEMENT LITIGATION COULD HELP IMPROVE PATENT QUALITY 21-23 (2013) (showing more software patents are asserted by patent monetization entities); Allison, Lemley & Walker, *supra* note 55, at 16-20 (showing different technologies and industries of most litigated patents, many of which were asserted by NPEs); Risch, *supra* note 3, at 477-78 (showing differing technology types between highly litigious NPEs and general patent pool).

shown below, non-NPEs assert plenty of software patents themselves with varying degrees of success. The difference is that NPEs do not assert *other* technologies, like therapeutics.

One explanation of the differential for technology is the layering of the patent system. Software and other high technology patents may be more easily developed by individuals and smaller companies with fewer resources. These companies tend to be the primary patent sources for highly litigious NPEs, leading to more assertions. There is no reason, for example, why other patentees with the ability to invent but not productize would stay away from patent assertions. Some have posited, for example, that universities will begin to partner with NPEs for enforcement of pharmaceutical and medical device patents,<sup>66</sup> a theory consistent with the layered patent system even if it has yet to come to widespread fruition.<sup>67</sup>

#### A. PTO TECHNOLOGY CLASSES

Table 4 lists the top technology classes for both the NPE and non-NPE set.<sup>68</sup> For each group, the table shows the percentage of patents that fell within the top classes. The table also shows the percentage of patents that fall into the same classes for the *other* group for a quick comparison.

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66. Feldman & Price, *supra* note 12, at 796 (“Our suspicion was that these university [bio patent] holdings would provide a fertile hunting ground for monetizers.”).

67. *But see* Mitch Smith, *Patent Protector or Pest?*, INSIDE HIGHER ED (May 17, 2012), <https://www.insidehighered.com/news/2012/05/17/higher-ed-split-merits-patent-company-intellectual-ventures> (discussing Intellectual Ventures and university patent monetization).

68. Technology classes have changed over time. Current classifications were used here.

Table 4. Top PTO Technology Classes (NPE and Non-NPE)

Top Non-NPE Classes				Top NPE Classes			
Class		Non-NPE	NPE	Class		Non-NPE	NPE
514	Drug	4.17%	0.28%	379	Telephonic Commc'ns	2.40%	17.05%
362	Illumination	4.17%	0.28%	360	Mag. Info. Storage	0.00%	8.24%
348	Television	3.66%	6.53%	705	Fin. Bus. Meth.	1.01%	6.82%
424	Drug	3.54%	0.00%	348	Television	3.66%	6.53%
349	Liquid Crystal	2.53%	0.00%	709	Data Process. Trans.	1.89%	4.55%
379	Telephonic Commc'ns	2.40%	17.05%	358	Facsimile Proc.	0.25%	4.55%
210	Liquid Purif.	2.02%	0.00%	715	Display Pres.	0.38%	3.41%
340	Commc'n Electrical	1.89%	0.57%	725	Interact. Vid. Dist.	0.38%	2.84%
709	Data Processing Trans.	1.89%	4.55%	701	Locat. Data Proc.	0.25%	2.56%
606	Surgery	1.64%	0.28%	707	DB Data Proc.	0.13%	2.56%
546	Organic Comp.	1.64%	0.00%	310	Elec. Generat.	0.25%	2.56%
435	Molecular Bio.	1.64%	0.00%	463	Games	0.13%	2.27%
345	Comp. Graphics	1.64%	0.85%	455	Telecommc'ns	0.63%	2.27%
<b>Total</b>		32.83%	30.40%	<b>Total</b>		11.36%	66.19%

Table 4 allows for a quick examination of overlap—or lack thereof. For example, Class 514 (Drug) was the top class for non-NPEs, with 4.17% of the patents, but only 0.28% of the NPE group patents fell in that category. Similarly, Class 379 (Telephonic Communications) was the top class for the litigious NPEs, with 17%. Of the non-NPE patents, 2.4% fell into the same class, which appears in the left side as the sixth most frequent non-NPE class. Similarly, the sixth most frequent NPE class, 358 (Facsimile Processing), is 4.55% of NPE patents, but only 0.25% of non-NPE patents (and not in the top 10 list for non-NPEs).

The table shows very little overlap by technology class. It also shows that most NPE classes (66%) are bunched into the top 13 classes, while only half as many (33%) of non-NPE patents are in the top 13 classes. Non-NPE patents are more diverse and less focused on data processing, storage, business methods, and communications.

Organization by technology class is not without problems. The primary classes can be both overly broad and unduly narrow, and often do not provide granular detail about the inventions within each class. Further, and ironically, the classes do not allow for aggregation of similar inventions into fewer coherent technology categories.

## B. TECHNOLOGY ART GROUPS

In an effort to solve these dual problems, the patents here were grouped by art unit associated with their patent class.<sup>69</sup> The art units were then grouped into art groups. Art units and art groups are how the Patent Office organizes patent examination operations. Several classes will be examined within particular units, and the units are managed in larger groupings. This grouping provides description about the technology but also aggregates them.<sup>70</sup>

Table 5. Percentage of Patents in Select Art Groups

Technology	Non-NPE	NPE
Computer Architecture, Software, Information Security	13.91%	47.44%
Chemical Materials Engineering	11.50%	2.56%
Optics	10.75%	3.41%
Electrical Circuits & Systems	7.21%	4.26%
Sheet Container Making, Package Making, Receptacles Shoes, Apparel, Tool Driving or Impacting	3.92%	1.42%
Surface Transportation	3.41%	0.28%
Semiconductors/Memory	3.16%	0.57%
Printing/Measuring & Testing	2.78%	1.42%
Computer Networks	1.90%	4.55%
Amusement & Education Devices	1.77%	2.56%
Cryptography, Security	1.52%	1.99%
Electronic Commerce	1.01%	6.82%
Thermal & Combustion Technology, Motive & Fluid Power Systems	0.38%	2.56%
Cable TV Related	1.77%	9.09%
Computerized Vehicle Controls & Navigation; Radio Wave, Optical and Acoustic Wave Communication; Robotics & Nuclear Systems	0.25%	2.56%
Medical & Surgical Instruments, Treatment Devices, Surgery & Surgical Supplies	1.77%	0.00%
Organic Chemistry	5.31%	0.00%
Organic Compounds: Bio-Affecting, Body Treating, Drug Delivery, Steroids, Herbicides, Pesticides, Cosmetics, Drugs	3.41%	0.00%
Medical Instruments, Diagnostic Equipment, Treatment Devices	1.77%	0.28%

69. For the art unit/technology class correspondence, see U.S. Patent & Trademark Office, Patent Classification: Classes Arranged by Art Unit (Mar. 2016), <http://www.uspto.gov/patents/resources/classification/art>.

70. For an example of other reporting by art unit groups, see Dennis Crouch, *Patent Grant Rate by Technology Area*, PATENTLY-O (Aug. 11, 2014), <http://patentlyo.com/patent/2014/08/patent-grant-technology.html>.

Table 5 clarifies a few trends. Computer architecture, software, and information security is the most prevalent technology type for both groups, though the percentage is much greater—about 50%—for the NPE patents. The difference is extended when the computer networks group is added.

The data also shows several areas where few and even no NPE patents were litigated. For example, the second and third most prevalent categories for the non-NPEs were chemical and materials engineering (11.5%) and optics (10.75%). These two categories totaled about 6% for the NPE group. Further, there are several categories that were completely absent from the list of litigious NPE patents, virtually all of which relate to medicine and pharmaceuticals.

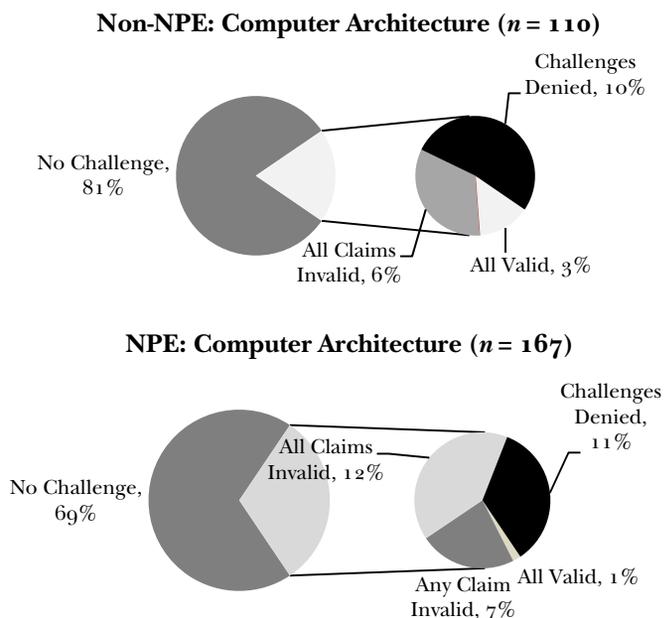
The following charts show validity outcomes for each group based on a few selected technology categories. Because only 3% of all cases involve a patent adjudicated on the merits, the charts show percentages of patents rather than percentages of cases. For each category, the large pie chart shows the percentage of patents that were unchallenged, which was most of them. The smaller pie chart shows the outcomes of patents that were involved in some sort of challenge. This representation allows for concise reporting of both the relative outcomes among those patents that were tested and absolute outcomes among all patents in the category.

Two striking differences are apparent in the first two charts for computer architecture and software technology ( $n = 110$  and  $167$ ). First, many more of the litigious NPE patents were challenged (31% versus 19%). Second, the primary difference between the two groups appears to be that about twice as many patents judged on the merits in the NPE group had at least one claim invalidated. The two groups had patents completely invalidated at approximately equal rates (about a third of all patents that were challenged in some way, though slightly more in the NPE group). The NPE group had another quarter of its patents with one or more (but not all) claims invalidated, whereas the non-NPE group had a greater percentage with challenges denied or held valid, and no patents with fewer than all claims invalidated.<sup>71</sup>

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71. Only one outcome per patent is displayed in each chart. Thus, there may have been patents with challenges denied or a subset of claims invalidated, but the most salient outcome was selected.

Figure 2. Computer Architecture: Validity Outcomes



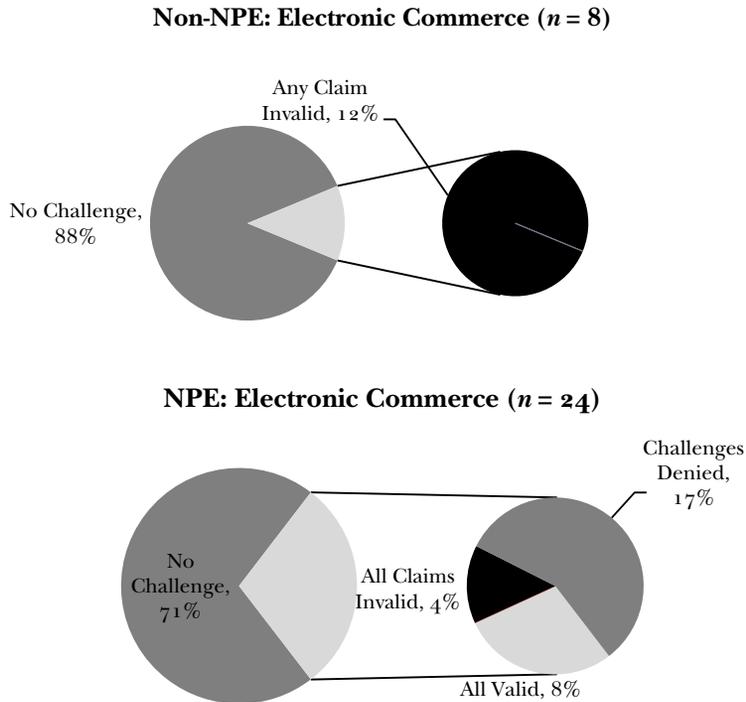
This may imply that the litigious NPE group enforced more patents that had at least one extremely broad claim that was more likely to be invalidated due to prior art or some other rule relating to claim scope, such as enablement or description.<sup>72</sup>

The computer architecture and software category stands in stark contrast to electronic commerce, which is also surprising. There was only one (successful) challenge among the non-NPE patents, though there were only eight patents in the group. The NPE electronic commerce patents were some of the most challenged technology in the study, with 44% seeing a challenge ( $n = 24$ ). Although heavily challenged, the challenges were almost completely unsuccessful. Less than 15% of the challenged patents were invalidated. Another 30% were found valid (two of the four valid patents in the entire study), and challenges were denied or pending at dismissal (but the patent was not resolved) in the remaining 55% or so. This is directly contrary to an expectation that these litigious NPEs asserted weak electronic commerce patents. Instead, these results imply that a few of the patents were electronic commerce and, despite being general purpose software, when challenged they were invalidated less often than other computer patents. It should be

72. Michael Risch, *What Is a Patent Troll?*, PRAWFSBLAWG (Apr. 15, 2011, 4:50 PM), <http://prawfsblawg.blogspot.com/prawfsblawg/2011/04/what-is-a-patent-troll.html> (“[T]rolls are trolls when they overreach.”).

noted that after changes in patentable subject matter jurisprudence,<sup>73</sup> these patents might well be invalidated today.<sup>74</sup>

Figure 3. Electronic Commerce: Validity Outcomes



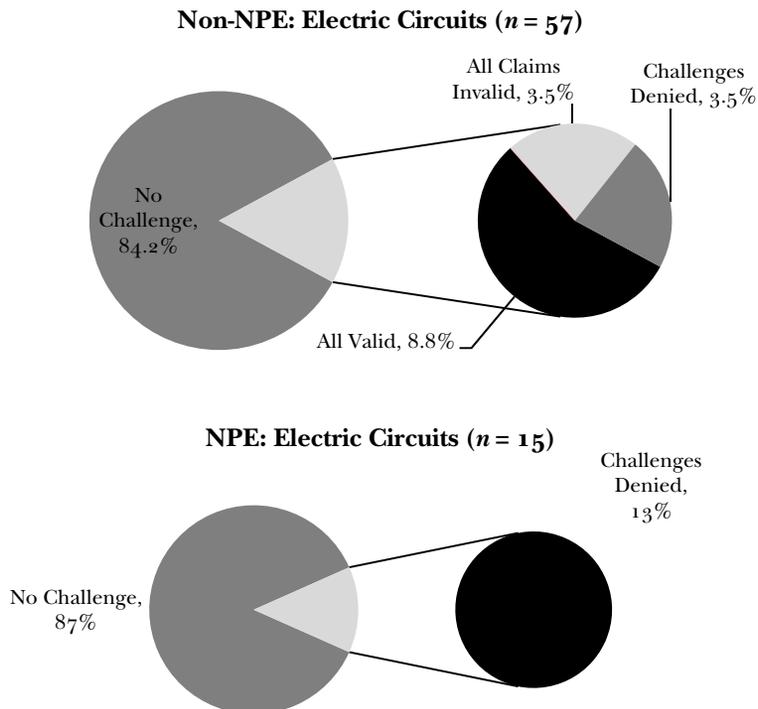
Other technologies fare better for both groups. In electric circuits, for example, fewer patents were challenged ( $n = 57$  and  $15$ ). In the non-NPE group, more than half the challenged patents were found valid, and another quarter had challenges denied. For the NPE group, all patents survived challenge but yielded no rulings on the merits. This is consistent with a preference for settlement among the litigious NPEs, even if the patents survived challenge.<sup>75</sup>

73. See generally *Alice Corp. v. CLS Bank Int'l*, 134 S. Ct. 2347 (2014) (expanding the scope of unpatentable abstract ideas).

74. Timothy B. Lee, *Software Patents Are Crumbling, Thanks to the Supreme Court*, VOX (Sept. 12, 2014, 3:50 PM), <http://www.vox.com/2014/9/12/6138483/software-patents-are-crumbling-thanks-to-the-supreme-court> (“[T]here have been 11 court rulings on the patentability of software since the Supreme Court’s decision—including six that were decided this month. Every single one of them has led to the patent being invalidated.”).

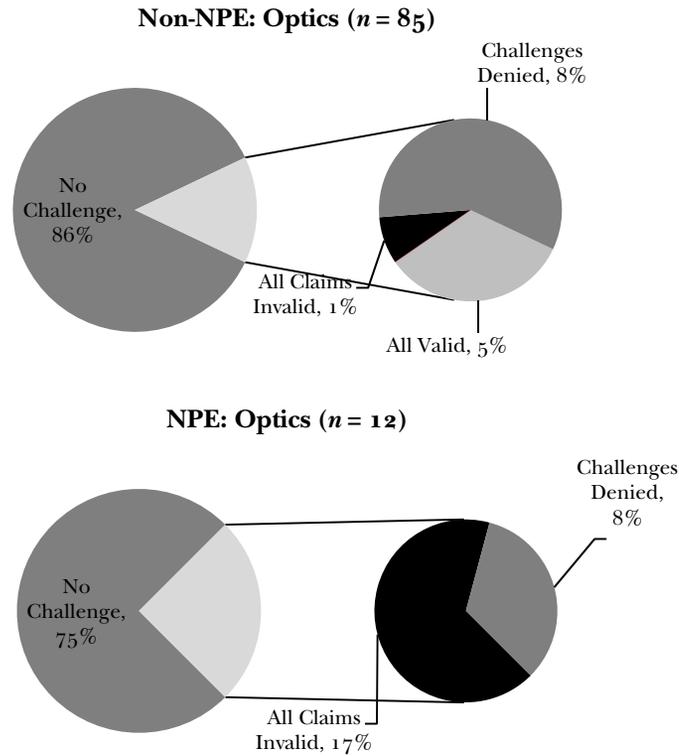
75. See Risch, *supra* note 13, at 102–05.

Figure 4. Electric Circuits: Validity Outcomes



Optics patents results were mixed ( $n = 85$  and  $12$ ). The non-NPE group was quite successful, with findings of validity or denied challenges, and had very few invalidations as compared to other categories. Among the NPE group, however, patents were challenged at a greater rate (although there were many fewer of them) and invalidated about two-thirds of the time when challenged. As Subpart C shows, the litigious NPE optics patents included more software patents. This may explain why more of the NPE patents were challenged and more were found invalid.

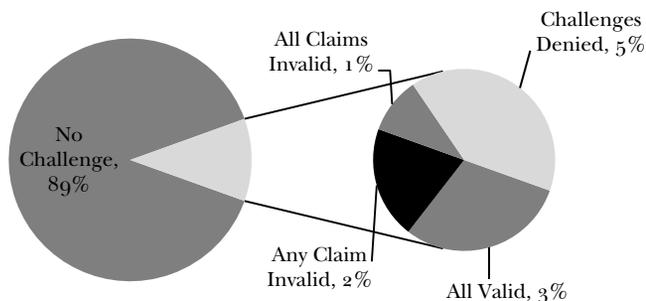
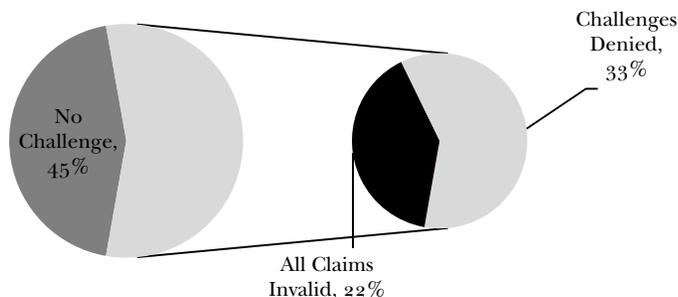
Figure 5. Optics: Validity Outcomes



These previous four categories—computer architecture, electric circuits, electronic commerce, and optics—have the largest overlap between the two groups. The groups where there is smaller, and even no, overlap provide an interesting contrast.

In chemical and materials engineering, patents were invalidated at about the same rate for both groups—about one-third ( $n = 91$  and  $9$ ). The primary difference was that a higher percentage of patents in the NPE group were challenged—55%. However, the sample is small, with the total number of NPE patents in this category at nine. The results are also consistent with other findings—the litigious NPE cases terminated with challenges being denied and a pretrial dismissal, while the non-NPE cases were more likely to terminate with a finding of validity.

Figure 6. Chemical and Materials Engineering: Validity Outcomes

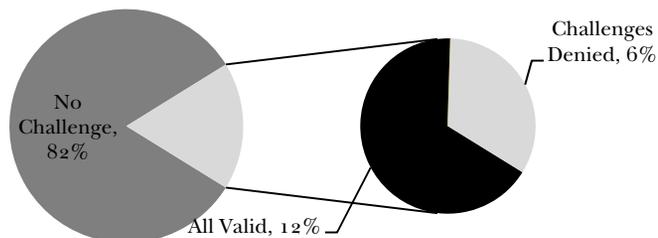
**Non-NPE: Chemical & Materials Eng. ( $n = 91$ )****NPE: Chemical & Materials Eng. ( $n = 9$ )**

The final three charts all relate to the non-NPE group because there were no NPE patents in those technologies. Biotechnology ( $n = 29$ ) appeared to fare better than medical instruments/diagnostics ( $n = 28$ ) and pharmaceuticals/organic chemicals ( $n = 69$ ). Though biotechnology patents were challenged more than the others, they suffered no invalidations. Indeed, the other groups were invalidated at about the same rate as non-NPE computer architecture patents when challenged—between 30% and 40%. The biotechnology finding is inconsistent with a similar study of all cases filed in a recent period, which leaves questions about how to assess this field.<sup>76</sup>

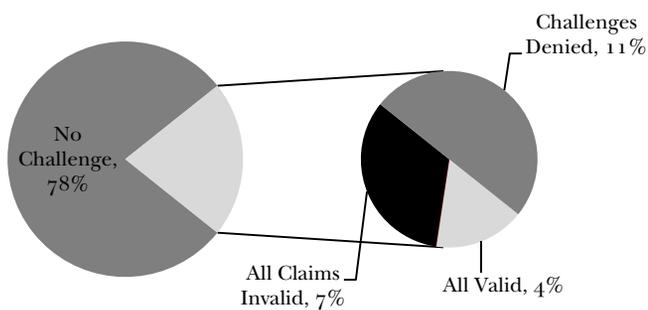
76. Allison, Lemley & Schwartz, *supra* note 2. *But see* Christopher M. Holman, *Do Biotech Patent Lawsuits Really “Overwhelmingly Lose?”: A Response to Our Divided Patent System*, 34 BIOTECHNOLOGY L. REP. 59, 59 (2015) (using a different interpretation of case statistics to conclude that biotech patent enforcement litigation “is not nearly as bleak” as has been suggested).

Figure 7. Biotechnology, Medical Instruments/Diagnostics, and Pharmaceuticals/Organic Chemicals: Validity Outcomes

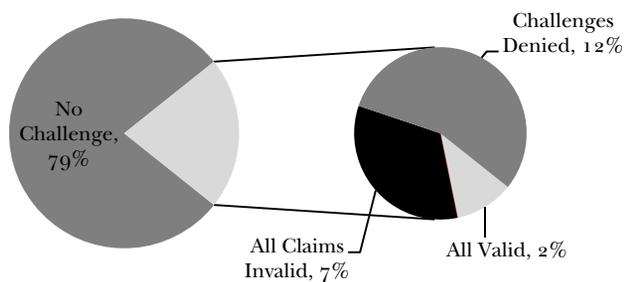
**Non-NPE: Biotech Microbiology & Recombinant DNA  
(n = 17)**



**Non-NPE: Medical Instruments & Diagnostics (n = 28)**



**Non-NPE: Organic Chemistry (n = 42)**



## C. SOFTWARE

Finally, given findings that software is related to NPE litigation,<sup>77</sup> this study examines patents for software related inventions. Following Graham and Vishnubhakat,<sup>78</sup> software patents were identified by technology class. This method may miss certain data processing patents, but it is largely accurate and has the benefit of being reproducible.<sup>79</sup> Software can be divided into two types: (1) general purpose software, which is more like “pure” software; and (2) hardware-specific software, which is software incidental to some more specific tangible invention. Software falling in each of these two groups of classes does not necessarily overlap; a total of seven patents across both sets are coded for both software types.

There are substantial and statistically significant differences between the two groups. About 10% of non-NPE patents are general software, while 30% of NPE patents are general software. The differences are less stark for hardware-specific software: 25% of non-NPE patents and 30% of NPE patents. Thus, about 66% of the litigious NPE patents cover some sort of software, as compared to 38% of the non-NPE patents.<sup>80</sup>

Table 6 shows the percentage of each technology category made up of the two different software patent types. The total percentage of software patents in each technology category is the sum of general and specific software. For example, 100% of electronic commerce patents are software-based, though in the NPE group 12.5% of them are hardware-specific.

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77. U.S. GOV'T ACCOUNTABILITY OFFICE, *supra* note 65, at 21 (noting that software “patents were at issue in the lawsuits that accounted for about 89 percent of the increase in defendants” between 2007 and 2011).

78. Graham & Vishnubhakat, *supra* note 26, at 75 n.7.

79. Bronwyn H. Hall & Megan MacGarvie, *The Private Value of Software Patents*, 39 RES. POL'Y 994, 997–98 (2010) (describing attempts to reproducibly define software patents and type I and II errors associated with the same).

80. U.S. GOV'T ACCOUNTABILITY OFFICE, *supra* note 65, at 21–22 (finding that monetization plaintiffs brought had roughly double the number of software patents in lawsuits).

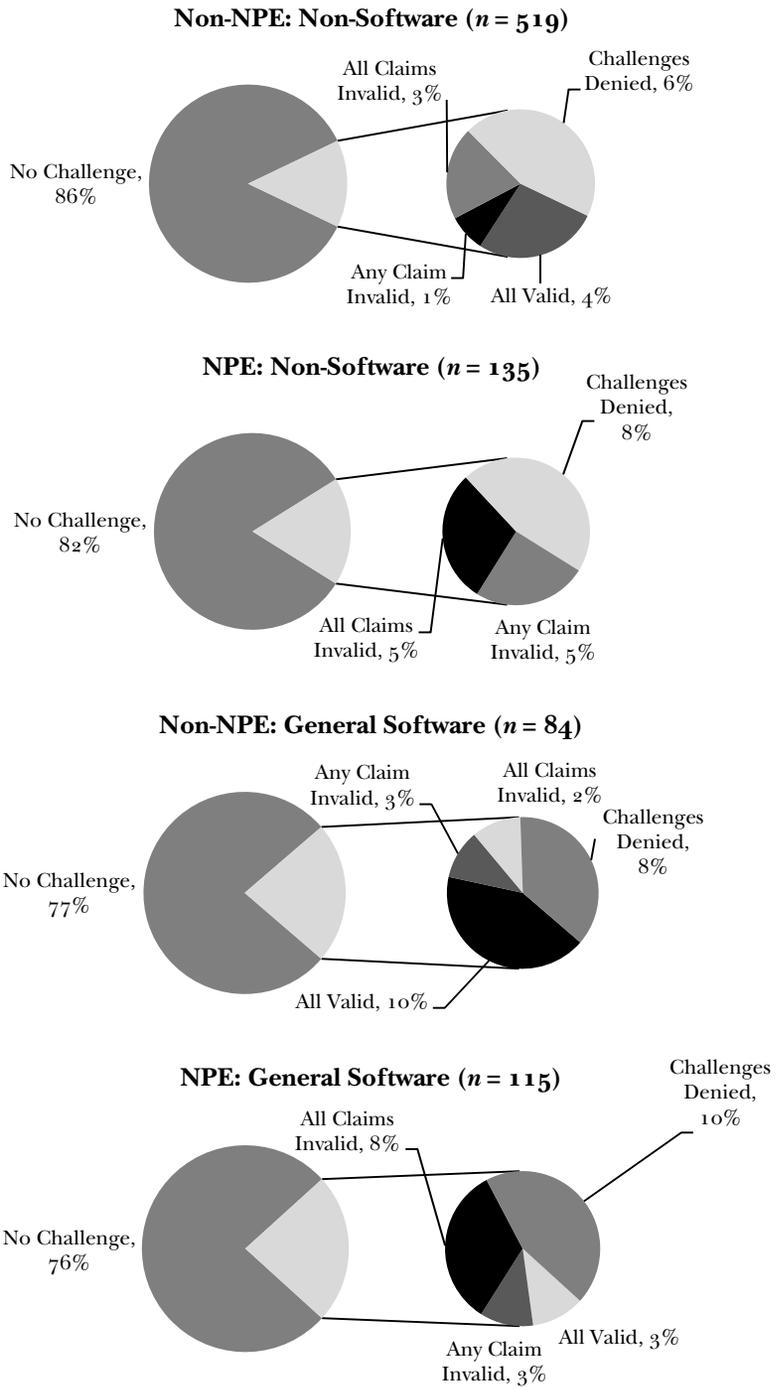
Table 6. NPE and Non-NPE Patents by Technology Category

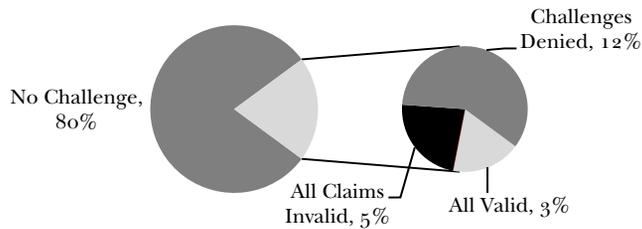
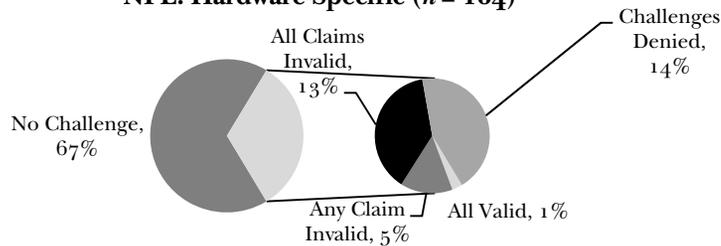
Technology	Non-NPE		NPE	
	General Software	Hardware-Specific	General Software	Hardware-Specific
Aeronautics, Agriculture, Weaponry	0.00%	15.38%	0.00%	0.00%
Amusement & Education Devices	0.00%	7.14%	0.00%	77.78%
Body Treatment, Kinestherapy, Exercising	0.00%	11.76%	0.00%	0.00%
Cable	21.43%	78.57%	31.25%	68.75%
Computer Architecture, Software, Information Security	33.64%	63.64%	28.74%	28.74%
Computer Networks	100.00%	0.00%	100.00%	0.00%
Computerized Vehicle Controls & Navigation; Radio, Optical & Acoustic Wave Communication	100.00%	0.00%	100.00%	0.00%
Cryptography, Security	58.33%	41.67%	71.43%	28.57%
Digital, General, & Optical Communications; Telephony, Audio, & Multiplex Communications; Cellular Telephony; Radio & Satellite	75.00%	100.00%	50.00%	100.00%
Electrical Circuits & Systems	0.00%	29.82%	0.00%	33.33%
Electronic Commerce	100.00%	0.00%	87.50%	12.50%
Medical Instruments, Diagnostic Equipment, Treatment Devices	0.00%	100.00%	0.00%	100.00%
Multiplex Communications	100.00%	0.00%	100.00%	0.00%
Optics	0.00%	22.35%	0.00%	66.67%
Printing/Measuring & Testing	4.55%	72.73%	20.00%	0.00%
Refrigeration, Vaporization, Ventilation, Combustion	0.00%	0.00%	0.00%	50.00%
Semiconductors/Memory	0.00%	48.00%	0.00%	100.00%
Television & TV Recording, Video Distribution, Image Analysis, (Fax, Printing, Printing Network, Scanners), Speech, (Fax, Disk Drive), Computer Graphics, Display	9.09%	90.91%	0.00%	100.00%
Video Compression/Recording	0.00%	100.00%	0.00%	100.00%

The table shows that software patents are not limited to electronic commerce and computer networks; they appear in a variety of different categories. At the same time, not every patent is software based, even in the computer architecture category. There were many categories with no software patents, and some of the categories in the table, like optics, have more non-software patents than one might expect.

Figure 8 considers patent validity for software. Each chart shows the percentage of patents in each group that were tested on the merits, and then shows percentages of each type of holding in a separate pie chart that shows the relative findings on the merits.

Figure 8. Software: Validity Outcomes



**Non-NPE: Hardware-Specific ( $n = 193$ )****NPE: Hardware-Specific ( $n = 104$ )**

In one sense, the charts are not surprising given that NPE patents were invalidated about twice as often as non-NPE patents. Among both groups, nonsoftware patents ( $n = 519$  and  $135$ ) were challenged less often. When they were challenged, as expected, about twice as many NPE patents were invalidated as compared to NPE patents. As noted above, however, there were many fewer NPE patents to invalidate both because there were fewer patents in general, and also because a much smaller proportion of them claimed no software.

In another sense, the results are indeed surprising. General software patents ( $n = 84$  and  $115$ ) appear to perform better than hardware-specific software patents ( $n = 193$  and  $104$ ) for both groups in terms of claims held valid. On the one hand, this may imply that the general software is stronger. On the other hand, it might imply that defendants were more willing to take general software cases to judgment, but lost. This second alternative seems reasonable because the invalidation rate appears to be about the same (within each plaintiff type) between general and hardware-specific. Thus, the only variation is whether a challenge is denied or left pending at settlement versus whether the challenge was tried and the patent was found valid.

This settlement question is an interesting one. There were only 16 denied challenges in the NPE group as a whole that were mooted or pending at

dismissal.<sup>81</sup> Of those 16, *ten* were in the general software group, and *none* were in the hardware-specific group. In fact, these ten comprised the bulk of all 12 denied challenges.<sup>82</sup> In other words, challenges were rarely denied in the general software group—either a ruling was issued or the case was dismissed. This is contrary to the intuition that general software patents were less amenable to settlement. It appears to be bimodal: about half went for judgment, and half dismissed out. Among the hardware-specific software patents, litigants appeared to be willing to wait for a ruling before settling or dismissing.

In all events, however, the data is surprising to the extent that general software patents are not invalidated any more often than the hardware-specific patents. The non-NPE group's patents fared even better, surviving more than 75% of the time when challenged. Most surprising, for both groups, nonsoftware patents fared worse than general software patents.<sup>83</sup>

These findings are inconsistent with a narrative that software patents are worse than other patents. However, the results are consistent with a layered approach to the patent system. It is not enough to simply compare software patents to nonsoftware patents; examination by technology group and even patentee and plaintiff type is also necessary. For example, the results imply that these highly litigious NPEs may be better at selecting software patents than nonsoftware patents—at least in terms of quality.

The invalidity outcomes also show why patentable subject matter rulings are so important to defendants—general software patents were harder to invalidate when tested on other patentability criteria. These results illustrate the importance of how results are counted; for example, these results considered all failed challenges, longitudinally considering every case in which patents were asserted. Studies that do not consider challenges pending at settlement or that cross-sectionally examine litigation may yield different results.<sup>84</sup>

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81. Failed challenges included those that were denied as moot and those that were pending at settlement. Only motions actually heard were included; motions denied as moot for being filed too late or as unripe for being too early, for example, were not counted. Contrary to the conventional wisdom that NPEs dismiss cases to avoid challenges, there were very few such dismissals in the dataset—12 patents were so dismissed at one point or another, with another seven mooted. However, these failed challenges were only counted if the patent was not subject to a later determination of validity, which left only 16 in the dataset—a mix of pending and mooted challenges (4.5% of the NPE patents). By contrast, there were 34 patents with failed challenges in the non-NPE set (4.2%).

82. In the non-NPE group, the ratio was 2:7.

83. *But see* Allison, Lemley & Schwartz, *supra* note 2, at 1083, 1140 (finding software patents fared much more poorly when tested than other patent technology but not including challenges pending when cases were dismissed).

84. For example, this study presents the invalidation status of each patent asserted only once; one invalidation will wipe out ten denials in other cases. A cross-sectional study might present partial invalidation of the same patent in two different cases twice but also present three denials in different cases.

Furthermore, the results show that attempts to curb patent trolls by making software more difficult to patent<sup>85</sup> may have unintended consequences against non-targeted patent owners, such as the NPEs here who by and large asserted patents that survived challenge.

#### D. POLICY IMPLICATIONS

The policy implications of the technology findings are twofold. The first is well-known—broad patent reform intended to curb litigious NPEs might create a risk to the entire patent system if non-NPEs are asserting different types of patents. Further, there is *some* overlap between the two groups, which means reforms targeted at specific types of patents will affect non-NPEs that hold similar patents.<sup>86</sup> Of course, if one believes that every patent in a particular category is problematic, then a focus on that technology may be preferable to a focus on the type of patent owner.

A second implication is that different patent classes will create different reasons for invalidation. For example, while about 47% of the NPE patents were in the computer architecture category, virtually all of the NPE invalidations—whether for anticipation, obviousness, written description, or definiteness—fell in that category.<sup>87</sup> In contrast, reasons for invalidation were spread much more evenly among the non-NPE patents because the technology was spread more evenly. Of course, this could mean that defendants simply chose the strongest reason to challenge and won on that basis. This is doubtful, however, given that defendants usually challenge on multiple bases.<sup>88</sup> Further, even if selection is at play, the results still imply that the strongest reason to invalidate differed between the groups.

The takeaways here are ambiguous. On the one hand, one could argue that NPEs simply assert invalid patents more often. On the other hand, it could be that the types of patents that NPEs assert are more likely to fail description, enablement, and definiteness rules, even if hardware-specific.

Third, despite protestations that litigious NPEs might begin asserting therapeutic patents,<sup>89</sup> evidence of such assertions had not materialized among highly litigious NPEs as of 2009. One reason may be that the therapeutic

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85. See, e.g., Chuang, *supra* note 17, at 245–47 (suggesting stricter limitations on software patents to limit patent troll activity).

86. See, e.g., Tim Molino, *Strengthening the Patent System by Ending Patent Abuse*, BUS. SOFTWARE ALLIANCE: TECHPOST (Mar. 19, 2015), <http://techpost.bsa.org/2015/03/19/strengthening-the-patent-system-by-ending-patent-abuse> (supporting reform on tactics rather than types of patenting). In general, a shift to a focus on tactics may be a realization (by some, at least) that plaintiff labels are increasingly unhelpful. Risch, *supra* note 47, at 127 (discussing difficulties in definitions).

87. *But see* Miller, *supra* note 13, at 49–50 (finding that NPE patents are more likely to be invalidated for obviousness or anticipation, regardless of technology).

88. See John R. Allison, Mark A. Lemley & David L. Schwartz, *Understanding the Realities of Modern Patent Litigation*, 92 TEX. L. REV. 1769, 1789 (2014).

89. See generally Feldman & Price, *supra* note 12 (arguing that biotech and pharmaceutical patents are especially susceptible to patent trolling).

technology and patentee layers simply do not overlap with NPE enforcement layers, even among universities. Even today, university patents asserted by patent aggregators are not among the most common patent plaintiffs, despite known relationships between the two types of entities.

## VI. THE WHOLE ELEPHANT

The data collected can shed some light on patent quality by enforcer, patentee, and technology type.<sup>90</sup> It can also help show how the repetitive assertion of patents affects invalidation. The data allows for a regression to test whether patent invalidity findings are correlated with patent characteristics (such as the number of claims), with technology characteristics (such as software), with plaintiff characteristics (such as licensing companies), with initial patentee characteristics (such as public companies), or with litigation selection choices (such as number of defendants).

The method involves a stepped regression that adds and removes variables and observes changes in the estimates, if any. Prior analysis found that once selection effects were included in the model, status as an NPE did not affect the likelihood of a patent being invalidated.<sup>91</sup> While NPEs were more likely to sue more defendants, assert patents more often, and assert more patents in each case, invalidations were more likely when any plaintiff did so, not just NPEs.

The regression here adds new information. Other studies have found that technology areas can make a difference in litigation,<sup>92</sup> but those studies typically examine differences only among patents for which a court issues a ruling one way or the other. The data in this study extends the analysis by including *all* of a patent's lifetime assertions, including the times when it was not invalidated or even tested on the merits.

Including every patent assertion rather than just those with a judicial ruling allows for a better assessment of the likelihood of a particular patent to be invalidated in any given case; it may be, for example, that computer architecture patents are invalidated more often because they are asserted more often or against more defendants. Or, a particular type of patent may be invalidated less often because it is asserted by a party that does not like to go to judgment. These effects can only be disambiguated if every patent assertion is considered. Without including every assertion, the data may be biased toward only those patents or litigations most likely to lead to a ruling on the merits. Thus, each data point is a case-patent pair: the outcome of patent validity in a given case.<sup>93</sup>

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90. The data does not allow for regression testing by entity size.

91. Risch, *supra* note 13, at 111.

92. For a recent example, see generally Allison, Lemley & Schwartz, *supra* note 2.

93. Errors were clustered by patent number and by case number with similar results.

The following are variables that are included in each of the four regression estimates:

**Claim Invalid:** This is the dependent variable equal to 1 if any claim in the patent was invalidated in that case, and 0 if no claims in the patent were invalidated in that case.<sup>94</sup> One limitation of the data is that patent claims invalidated during reexamination while a case was pending are coded as not invalidated when, in fact, the PTO invalidated the claim.

**Patentee is Public:** 1 if the initial assignee is publicly traded or an affiliate of a public company.

**Reexam-Added:** 1 if claims were added to the patent in reexamination, 0 otherwise.

**Log backward citations:** The logarithm of the number of patents and other references cited by the patent at issue.

**Log adjusted forward citations:** The logarithm of the number of patents that cite to the studied patent, normalized by yearly cohort.

**Log pendency:** The logarithm of the number of days between the very earliest priority date of the patent and its issuance.

**Number continuations:** The number of times a new continuation application was filed to obtain the patent; how removed from the original filing are the claims?

**Log claim count:** The logarithm of the number of claims in the patent.

**Log priority to suit:** The logarithm of the number of days between the earliest patent application date and the lawsuit; a larger difference reduces the amount of prior art available and makes it harder to invalidate.

**Year filed:** The year the case was filed.

**Number of inventors:** How many inventors on a patent.

**Reexamined:** The number of times the patent has been reexamined. Either the patentee seeking to enforce or threatened defendants could seek reexamination.

**Stayed:** 1 if the case was ever stayed, 0 otherwise. Cases are often stayed pending reexamination by aggressive defendants, though there were a few bankruptcy stays.

**Xfer/Consolidation:** 1 if the case was ever transferred or consolidated. This too can imply an active defendant or a high activity patent.

**Num, Defs:** The number of defendants in a case. The more defendants, the more likely one will challenge the patent.

**Dec. Relief:** Whether the case was solely a declaratory relief action by a defendant.

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94. An alternate regression was tested with ordered (rather than binary) outcomes, such as unchallenged, challenge denied, some claims invalid, all claims invalid, and all claims valid. The results were essentially the same.

**Prior Assertions:** The number of times the patent has been asserted as of the case filing date, including the current case. Cases filed on the same day have the same number assigned.

**Total Assertions:** The number of times the patent was asserted in all cases in the set.

**Num. Patents Case:** The number of patents in the same case as the studied patent.

Each of the first three regressions tests one of the layers:

1. Regression 1 includes the factor variable *Plaintiff Type*, which categorizes the enforcer by business model. The base level is Product Company, so any coefficients represent a change from a product company plaintiff to some other type.
2. Regression 2 includes the factor variable *Initial Assignee Type*, which categorizes the initial assignee by business model. Product Company plaintiffs are also the base level for this variable.
3. Regression 3 includes the factor variable *Technology Group*, which categorizes the patented technology.
4. Regression 4 includes all three of the previous factors: *Plaintiff Type*, *Initial Assignee Type*, and *Technology Group*.

For brevity, the results omit several technology groups with statistically insignificant results. They also omit variables that saw no invalidation. For example, no patent asserted by an IP affiliate was found invalid in the entire dataset, eliminating about 200 case–patent pairs from plaintiff type models. Similarly, no patent in the organic drug category was found invalid, eliminating about 250 pairs from technology models.

Table 7. Patent Quality by Plaintiff Type, Initial Assignee Type, and Technology Group

	(1) claim invalid	(2) claim invalid	(3) claim invalid	(4) claim invalid
<b><i>Plaintiff Type</i></b>				
Licensing (Acquired)	3.927** (0.004)			1.981 (0.263)
Failed Startup	54.19*** (0.000)			3.044 (0.394)
Inventor Owned Co.	1.041 (0.937)			0.393 (0.290)
<b><i>Initial Assignee Type</i></b>				
Failed Startup		19.66*** (0.000)		15.29*** (0.000)
Inventor Owned Co.		1.888 (0.316)		1.444 (0.639)
Govt or NGO		3.068 (0.206)		3.925 (0.207)
Startup—Preproduct		3.141 (0.362)		2.255 (0.207)
Individual		5.466*** (0.000)		3.846** (0.000)
IP Affiliate of Product Co.		0.203 (0.173)		0.539 (0.676)
<b><i>Technology Group</i></b>				
Organic Chemistry			0.381 (0.276)	0.151 (0.072)
Chemical & Materials Engineering			0.474 (0.366)	0.238 (0.097)
Cable, Television			0.111 (0.090)	0.0140** (0.005)
Computer Networks			0.342 (0.247)	0.109* (0.038)
Comp. Architecture, Software & Info. Sec.			0.122** (0.009)	0.0561*** (0.001)
Digital Comm.			0.418 (0.388)	0.119 (0.093)
Electrical Circuits & Systems			0.0318** (0.002)	0.0202** (0.004)
Printing/Measuring & Testing			0.379 (0.450)	0.147 (0.179)
Optics			0.0163*** (0.000)	0.0128*** (0.000)
Surface Transportation			0.0414** (0.004)	0.0373** (0.004)
Electronic Commerce			0.0365* (0.028)	0.0197* (0.011)
Medical & Surgical Instruments			0.0223** (0.009)	0.0154** (0.007)
<b><i>Other Parameters</i></b>				
Patentee Is Public	0.422 (0.360)	0.752 (0.747)	0.401 (0.229)	0.642 (0.614)
Reexam—Added	0.0507** (0.001)	0.0513** (0.001)	0.159* (0.028)	0.0705* (0.016)

	(1) claim invalid	(2) claim invalid	(3) claim invalid	(4) claim invalid
Log Backward	1.454 <sup>*</sup> (0.015)	1.288 (0.154)	1.435 <sup>*</sup> (0.040)	1.331 (0.158)
Log Adj Forward Citations	0.846 (0.411)	1.182 (0.403)	1.130 (0.554)	0.898 (0.654)
Log Pendency	0.956 (0.903)	1.272 (0.530)	0.786 (0.571)	1.102 (0.818)
Log Claim Count	1.084 (0.651)	1.104 (0.568)	1.054 (0.767)	1.171 (0.443)
Year Filed	1.004 (0.954)	1.117 (0.129)	1.041 (0.393)	1.079 (0.275)
Log Priority to Suit	0.525 (0.142)	0.373 <sup>*</sup> (0.032)	0.465 <sup>*</sup> (0.045)	0.439 (0.104)
Number of Inventors	0.883 (0.338)	1.051 (0.672)	0.888 (0.289)	0.929 (0.604)
Number of Continuations	0.986 (0.630)	0.998 (0.954)	1.000 (0.990)	0.997 (0.915)
Rexamined	1.421 <sup>*</sup> (0.013)	1.378 <sup>*</sup> (0.036)	1.575 <sup>**</sup> (0.006)	1.478 <sup>*</sup> (0.025)
Stayed	8.947 <sup>***</sup> (0.000)	4.305 <sup>**</sup> (0.001)	8.358 <sup>***</sup> (0.000)	6.267 <sup>***</sup> (0.000)
Xfer/Consolidation	11.77 <sup>***</sup> (0.000)	8.183 <sup>***</sup> (0.000)	10.18 <sup>***</sup> (0.000)	11.65 <sup>***</sup> (0.000)
Num Defs	1.028 <sup>***</sup> (0.000)	1.030 <sup>***</sup> (0.000)	1.043 <sup>***</sup> (0.001)	1.032 <sup>***</sup> (0.000)
Dec. Relief	1.253 (0.514)	1.083 (0.827)	0.980 (0.962)	1.053 (0.907)
Prior Assertions	0.968 <sup>*</sup> (0.012)	0.965 <sup>*</sup> (0.017)	0.969 <sup>*</sup> (0.017)	0.962 <sup>**</sup> (0.005)
Total Assertions	1.034 <sup>***</sup> (0.000)	1.039 <sup>***</sup> (0.000)	1.039 <sup>**</sup> (0.003)	1.042 <sup>**</sup> (0.003)
Num Patents Case	0.989 (0.470)	0.989 (0.486)	0.967 (0.959)	1.013 (0.283)
Observations	5295	5538	4442	4218
Pseudo $R^2$	0.333	0.353	0.322	0.357
Chi-squared	214.0	462.7	413.0	
$p > X^2$	0.000	0.000	0.000	

Exponentiated coefficients;<sup>95</sup>  $p$ -values in parentheses \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

The first result, consistent across all four regressions, is that selection variables—including number of defendants, number of times the patent is asserted, transfers, consolidations, stays, and reexaminations—are statistically significant and positively correlated with invalidation findings. Indeed, many of the values change very little, regardless of the type of plaintiff, patentee, or

95. Exponentiated coefficients in a logistic regression can be read as a percentage change in the non-transformed dependent variable. For each unit the independent variable changes, the likelihood of invalidity increases or decreases by the percentage above or below one. Thus, a coefficient below one implies a decrease in likelihood of invalidity.

technology. This serves as a robustness test for previous findings that litigation choices likely foretell invalidation more than any other observable factor.<sup>96</sup>

The second result, also consistent across all four regressions and with prior work, is that observable patent characteristics such as claims, forward citations, patent age, and continuations are not significant in the model. Two of the estimates include a significant coefficient on backward citations, but in a surprising direction—more citations increase chances of invalidity. This is consistent with prior work<sup>97</sup> and implies that more backward citations may be better evidence of highly challenged patents than patent quality. Note, however, that this factor loses its statistical significance when the type of patentee is included in the estimation.

With respect to enforcer, assignee, and technology layers, the results show how complex the interactions are. For example, in regression (1), both licensing entities and failed startups were more likely to have patents invalidated as compared to product companies, but inventor-owned companies were only slightly more likely, all else equal, and the coefficient was not significant.<sup>98</sup> This alone implies that any blanket categorization of different plaintiff business models as an NPE is too simple.<sup>99</sup>

Regressions with interactions (not reported) revealed similar results: outcomes of individually obtained patents were more likely to be invalidated whether or not licensing companies or product companies asserted them. However, licensing companies asserting such patents did a bit worse asserting patents from the same source.

However, in regression (2), patents initially assigned to failed startups continued to signal invalidation at high rates, but *no* patents initially assigned to licensing entities were found invalid. Additionally, patents obtained by individuals were more likely to be invalidated. This points to a potential interconnection between layers because licensing entities obtain many patents from individuals. It also points to potential omitted variable bias in regressions (1) and (2): is invalidation risk more correlated with licensing *plaintiffs* or with individual *patentees*?

Venture capitalization, or lack thereof, is a potential source of concern for the failed startups. Not one of the failed startups assigned a patent later litigated had venture funding. The reasons for this are unknown. The failed startups could have failed precisely because they had no financing, and venture-backed firms were savvy enough to sell their patents and remain in

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96. Risch, *supra* note 13, at 92–97.

97. *Id.* at 118–22.

98. This is particularly surprising, given that many invalidations were of patents owned by Ronald A. Katz Licensing, an inventor-owned plaintiff.

99. *Accord* Risch, *supra* note 13, at 121 (finding that NPE status was insignificant and added no explanatory value in addition to litigation selection effects).

operation.<sup>100</sup> Or, failed startups with no financing may have simply not had the funds to obtain better patents, a story usually reserved for individuals. For both lack of venture capital funding and individuals, one takeaway is that lack of funding at the time of patenting—not just at the time of litigation—is important. More money may make for better patents.<sup>101</sup>

Regression (3) yields some interesting results. First, each of the coefficients is far below 1, which implies that adding the technology group makes a patent less likely to be invalidated. That can't be right, however, because every patent has a technology. The small coefficients are likely because so few patents in each group are invalidated. Indeed, some technology fields are omitted because there were no invalidations in this sample. These include biotechnology, microbiology, cryptography, video compression, multiplex communication, and semiconductors, among others.

In the group with the most invalidations, computer architecture, only slightly more than 12% of the case–patent pairs included an invalid claim. Thus, the best way to understand these coefficients may be in comparison to each other. For example, computer architecture patents were much more likely to be invalidated than cable, optics, or electric circuit patents, all else equal.

But here, too, something may be missing. Perhaps some patentees obtained better computer architecture patents than others. Regression (4) combines all three of the layers, and the results are surprising. First, plaintiff type no longer seems to matter as much; the coefficients are smaller and no longer statistically significant. Among initial assignees, however, failed startups and individuals<sup>102</sup> are still statistically significant and imply a greater likelihood of invalidity finding.

One possible inference is that patents granted to individuals are more likely to be invalidated, regardless of who asserts them. This is an important observation. It means that the historic difficulties facing individuals in litigation<sup>103</sup> are not caused by litigation disadvantages as plaintiffs, but because of their patents. It is unclear how strong this inference is, because licensing companies are more likely to have patents invalidated, even if the coefficient is not statistically significant.

Additionally, the technology group coefficients indicate interaction between layers. Some coefficients, such as optics, medical instruments, and surface transportation are unchanged between estimates (3) and (4). Other coefficients are much smaller, though still statistically significant. For

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100. Colleen Chien, *Startups and Patent Trolls*, 17 STAN. TECH. L. REV. 461, 479–83 (2014) (discussing survey of startups who monetized patents for funding).

101. Cf. Arora et al., *supra* note 5 (finding that innovations coming from customers had lower value than those developed by companies themselves).

102. These are true individuals. Individual inventor-owned companies are a separate variable.

103. PRICEWATERHOUSECOOPERS LLP, *supra* note 4.

example, computer architecture decreases by more than half, from 0.112 to 0.048. Computer networks, cable/television, and electrical circuits also decreased substantially.

One inference from these changes in regression (4) is that plaintiff and initial assignee type is capturing some of the explanatory power of the model that would have ordinarily been attributed to technology alone. But the effect is only in certain technologies and not others. A close comparison of the different estimates provides some insight into the layered patent system. Party type seems to make more of a difference in computer architecture, cryptography, and electronic commerce, but not in surface transportation, optics, and medical instruments. The results may be driven in part by the technology choices of each type of assignee, an interesting finding in itself. However, quantity of patents cannot be the entire answer because product companies had patents in each of the technology groups that saw the largest changes.

Other, unreported regressions yield similar results with respect to software. When considered independently, software patents are about 2.5 times more likely to be invalidated than non-software patents. However, when the nature of the patentee and plaintiff is included, software status is no longer statistically significant in the model.<sup>104</sup> This result is potentially ambiguous. On the one hand, it is irrefutable that—on average—software patents were more likely to be invalidated. On the other hand, it implies that viewing a simple average of software patent outcomes may be biased because other, unobserved variables might affect patent quality and *also* yield more software patents. Given the growth of software and computer technology—especially as a proportion of all patents and litigation—over the past 25 years, it is not surprising that other factors might affect patent quality other than simply being software.

## VII. CONCLUSION: BEYOND THE PATENT TROLL NARRATIVE

A closer examination of the different layers of the patent system—including enforcers, patentees, and technology—reveals that the NPE narrative is far more complex than the usual discussion implies. Conventional discourse is an example of the “tail wagging the elephant.” These most litigious examples are an arbitrary extreme to exemplify the complexity of the patent system, but they illustrate that most of the research on patent trolls is somewhat arbitrary.<sup>105</sup> One researcher’s most litigious NPE may quite literally be another researcher’s practicing company.<sup>106</sup>

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104. The coefficient also decreases to nearly 1, implying no effect.

105. Risch, *supra* note 47, at 127 (“This definitional morass is a symptom of a bigger problem in the patent troll debate: a lack of analytical rigor that leads interested parties to talk past each other.”).

106. Risch, *supra* note 13, at 87 (discussing Network Signatures, coded as a highly litigious NPE by some, but as a practicing entity by others, depending on the time of identification).

For example, many of the Papst patents were originally invented by employees at Papst Moteren, a functioning product company at the time of patenting. It was only upon sale of the company that the son of one of the primary inventors obtained rights to pursue enforcement of the patents.<sup>107</sup> Similarly, many of the Katz Licensing patents were obtained on behalf of First Data Corporation, a public corporation through which most credit card transactions are cleared.<sup>108</sup> Catch Curve, which enforces patents for j2Global, an operating public company, may have been a wholly owned subsidiary of j2.<sup>109</sup> Even Rates Technology, a very small business, apparently offered telephone call rate-setting services to go along with patent licenses.<sup>110</sup>

The meme that NPEs have no technology transfer goals also seems to fail. Consider, for example, F&G and its scrolling mouse patent. F&G's first major litigation was a *trade secrets* case against Key Tronic for disclosing *pre-patent* information to Microsoft and others.<sup>111</sup> F&G won \$16.5 million dollars in a jury verdict,<sup>112</sup> and wound up on the most-litigious list when it asserted its patent against others who used the information (whether knowingly or not) and effectively locked F&G out of the market.

Calling productive companies NPEs and/or patent trolls continues beyond the most-litigious list. Consider Sovereign Software, which lost a well-publicized appeal to Newegg.<sup>113</sup> In reality, Sovereign bought the assets of a going concern with real customers, and it is hotly disputed how much effort Sovereign put in to maintaining, improving, and selling the product.<sup>114</sup>

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107. Daniel Papst, *NPEs and Patent Aggregators—New, Complementary Business Models for Modern IP Markets*, 48 LES NOUVELLES 94, 95 (2013) (“Georg Papst turned necessity into a virtue by making a high-risk investment in buying back the respective patent portfolios and founding the NPE ‘Papst Licensing.’”).

108. Robert Ambrogi, *For Ronald Katz, Patent Litigation Pays Billions*, IMS EXPERTSERVICES: BULLSEYE (Dec. 11, 2007), <http://www.ims-expertservices.com/bullseye/december-2007/for-ronald-katz-patent-litigation-pays-billions>.

109. *Subsidiaries of j2 Global*, JFAX.ORG (Aug. 29, 2014), <https://web.archive.org/web/20150212152604/http://jfax.org/article/subsidiaries-of-j2-global>.

110. Sabra Chartrand, *Patents; A Little Box Holds Out the Enticing Promise of the Lowest Long-Distance Rate Every Time You Call*, N.Y. TIMES (June 17, 1996), <http://www.nytimes.com/1996/06/17/business/patents-little-box-holds-enticing-promise-lowest-long-distance-rate-every-time.html>.

111. *Key Tronic Settles Suit with Scrolling Mouse*, PUGET SOUND BUS. J. (Oct. 24, 2002, 2:17 PM), <http://www.bizjournals.com/seattle/stories/2002/10/21/daily40.html>.

112. *See id.*

113. Joe Mullin, *How Newegg Crushed the “Shopping Cart” Patent and Saved Online Retail*, ARS TECHNICA (Jan. 27, 2013, 3:00 PM), <http://arstechnica.com/tech-policy/2013/01/how-newegg-crushed-the-shopping-cart-patent-and-saved-online-retail> (“The ruling in the Newegg case is a total wipeout for a patent troll . . .”).

114. *Compare* Osenga, *supra* note 17, at 459 (“Further, Sovereign Software is possibly mislabeled as a ‘formerly manufacturing entity,’ as it continues to offer Open Market’s Transact product for e-commerce business, as well as support, training, and consulting for the product. Sovereign’s customers range from mid-market to blue chip companies.” (footnote omitted)), *with Is Sovereign Software a Patent Troll? Yes*, END SOFTWARE PATENTS (Apr. 4, 2014), <http://endsoftpatents.org/2014/04/sovereign-software> (citing evidence of Sovereign activities, including the

The matching litigation side shows the similar traits in many of its plaintiffs. Both Network Signatures and US Ethernet LLC are now enforcing patents that used to be relevant to going businesses of varying success. Eastman Kodak enforced several patents in the set and later auctioned them off in bankruptcy; at least one of those litigated patents is now owned by Intellectual Ventures (a licensing NPE) and another is owned by Apple, Inc. (a product non-NPE).<sup>115</sup> Two patents appear in both sets: they were first enforced by the individual inventor, then assigned to a large product company, and then assigned to an NPE for enforcement.

This Article's somewhat agnostic analysis sheds some light on a policy debate dominated by pejoratives and blanket statements about frivolous patents and impeded innovation. Its goal has been to expand analysis to more of the layers of the patent system. There are surely more layers to be addressed in future research, such as inventor geography, citation, and spillovers. Putting these layers together allows policymakers to move beyond a single focused rhetoric to understand the complexities of the system.

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NewEgg brief opposing certiorari, which stated that "Petitioner generates tens of millions of dollars in income solely through patent litigation settlements and some de minimis residual maintenance and service fees from a few legacy Transact customers that Open Market originally licensed. Petitioner has not licensed a single new Transact customer." (citation omitted).

<sup>115</sup>. See Nick Brown, *Kodak Patent Sale Plan Gets Bankruptcy Court Approval*, REUTERS (Jan. 11, 2013, 1:32 PM), <http://www.reuters.com/article/2013/01/11/us-kodak-patent-sale-idUSBRE9oAoYN20130111>.