Irrational Ignorance at the Patent Office

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There is widespread belief that the Patent Office issues too many "bad" patents that impose significant harms on society. At first glance, the solution to the patent quality crisis seems straightforward: give patent examiners more time to review applications so that they grant patents only to those inventions that deserve them. Yet the answer to the harms of invalid patents may not be that easy. It is possible that the Patent Office is, as Mark Lemley famously wrote, "rationally ignorant." In Rational Ignorance at the Patent Office, *Lemley argued that because so few patents are economically significant, it makes sense to rely on litigation to make detailed validity determinations in those rare cases rather than increase the expenses associated with conducting a more thorough review of all patent applications. He supported his thesis with a cost-benefit calculation in which he concluded that the costs of giving examiners more time outweigh the benefits of doing so.*

Given the import of the "rational ignorance" concept to the debate on how best to address bad patents, the time is ripe to revisit this discussion. This Article seeks to conduct a similar cost-benefit analysis to the one that Lemley attempted nearly fifteen years ago. In doing so, we employ new and rich sources of data along with sophisticated empirical techniques to form novel, empirically driven estimates of the relationships that Lemley was forced to assume in his own analysis given the dearth of empirical evidence at the time. Armed with these new estimates, this Article demonstrates that the savings in future litigation

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and prosecution expenses associated with giving examiners additional time per application more than outweigh the costs of increasing examiner time allocations. Thus, we conclude the opposite of Lemley: society would be better off investing more resources in the Patent Office to improve patent quality than relying on ex post litigation to weed out invalid patents. Given its current level of resources, the Patent Office is not being "rationally ignorant" but, instead, irrationally ignorant.

INTRODUCTION

The principal task of the U.S. Patent & Trademark Office ("Patent Office" or "Agency") is to determine whether an invention merits a reward of a patent.[1] There is growing consensus that the Patent Office is failing at this task.[2] Many believe that the Agency allows too many "bad" patents that unnecessarily drain consumer welfare, stunt productive research, and unreasonably extract rents from innovators.[3] The Patent Office's overgranting tendencies have

1. U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT, FISCAL YEAR 2017, at tbl.3 (2017), https://www.uspto.gov/sites/default/files/documents/USPTOFY17PAR.pdf [https://perma.cc/YEQ7-9G2P] (noting the Patent Office's mission includes "[f]ostering innovation . . . and . . . delivering high quality and timely examination of patent . . . applications"). We use the term "patent" in this Article to refer to utility patents. Utility patents protect the way an article is used and works. *See* 35 U.S.C. § 101 (2012) ("Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent, subject to the conditions and requirements of this title.").

2. *See, e.g.*, JAMES BESSEN & MICHAEL J. MEURER, PATENT FAILURE: HOW JUDGES, BUREAUCRATS, AND LAWYERS PUT INNOVATORS AT RISK (2008) (noting several ways in which the issuing of patents may harm innovation and industry); *see also* ADAM B. JAFFE & JOSH LERNER, INNOVATION AND ITS DISCONTENTS: HOW OUR PATENT SYSTEM IS ENDANGERING INNOVATION AND PROGRESS, AND WHAT TO DO ABOUT IT 7 (2004) ("We wrote this book because patent policy in the United States has gotten seriously off the rails, in ways that endanger the long-term well-being of our citizens."); FED. TRADE COMM'N, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY 5–7 (2003), http:///www.ftc.gov/os/2003/10/innovationrpt.pdf [https://perma.cc/3JBV-7GCW] ("Both competition and patent policy can foster innovation, but each requires a proper balance with the other to do so. Errors or systematic biases in how one policy's rules are interpreted and applied can harm the other policy's effectiveness.").

3. *See, e.g.*, Roger Allan Ford, *Patent Invalidity Versus Noninfringement*, 99 CORNELL L. REV. 71, 87–88 (2013) ("Among patent scholars, there is almost unanimous agreement that patent examiners do not do their job particularly well, with the PTO issuing many invalid patents."); Mark A. Lemley, *Rational Ignorance at the Patent Office*, 95 NW. U. L. REV. 1495, 1495 (2001) ("The PTO has come under attack of late for failing to do a serious job of examining patents, thus allowing bad patents to slip through the system."); Mark A. Lemley & Bhaven Sampat, *Is the Patent Office a Rubber Stamp?*, 58 EMORY L.J. 181, 181 (2008) ("A growing chorus of voices is sounding a common refrain: the U.S. Patent and Trademark Office (PTO) is issuing far too many bad patents."); Dough Lichtman & Mark A. Lemley, *Rethinking Patent Law's Presumption of Validity*, 60 STAN. L. REV. 45, 47 n.5 (2007) ("Calls for patent reform have echoed loudly over the past several years, with industry organizations, patent scholars, and government agencies all publicly announcing that the patent system is broken and that the PTO in particular is letting a large number of undeserving patents be issued."); Robert P. Merges, *As Many as Six Impossible Patents Before Breakfast: Property Rights for Business Concepts and Patent System Reform*, 14 BERKELEY TECH. L.J. 577, 589–91 (1999) ("The concerns about quality, especially in light of the data on overall volume, point to one conclusion: the patent system is in crisis. "); John R. Thomas, *Collusion and Collective Action in the Patent System: A Proposal for Patent Bounties*, 2001 U. ILL. L. REV. 305, 316–22 ("The patent quality crisis is worthy of our attention. The market impact of business method patents alone has yet to be quantitatively assessed, but decisions such as *Amazon.com v. Barnesandnoble.com* suggest staggering possibilities."); R. Polk Wagner, *Understanding Patent-Quality Mechanisms*, 157 U. PA. L. REV. 2135, 2139–45 (2009) ("The patent-prosecution process is fraught with serious information problems of the sort that a robust marketplace might be able to resolve at least as well as an over-taxed administrative agency.").

been the subject of multiple reports by the National Academies and the Federal Trade Commission.[4] Patent quality concerns have energized the Supreme Court into taking a renewed interest in substantive patent law[5] and driven Congress in 2011 to enact the first major patent reform act in nearly sixty years.[6]

Although there is widespread agreement that invalid patents impose significant costs on society, there is little consensus as to how best to fix the patent system.[7] At first glance, the solution seems straightforward: the Patent Office needs to do more to ensure it awards patents only to those inventions that deserve them. A seemingly promising start—and one that is at the forefront of current policy discussions[8]—is to give patent examiners more time to evaluate applications. On average, a U.S. patent examiner spends only eighteen hours reviewing an application,[9] which includes reading the application, searching for prior art, comparing the prior art with the application, writing a rejection, responding to the patent applicant's arguments, and often conducting an interview with the applicant's attorney.[10] If examiners are not given enough time to evaluate applications, they may not be able to reject applications by identifying and articulating justifications with appropriate underlying legal validity. Offering validation for these concerns, recent reports commissioned by the federal government bemoan that examiners

4. *See, e.g.*, NAT'L RESEARCH COUNCIL, A PATENT SYSTEM FOR THE 21ST CENTURY (Stephen A. Merrill et al. eds., 2004) (discussing several issues with the patenting process); NAT'L RESEARCH COUNCIL, REAPING THE BENEFITS OF GENOMIC AND PROTEOMIC RESEARCH: INTELLECTUAL PROPERTY RIGHTS, INNOVATION AND PUBLIC HEALTH (Stephen A. Merrill & Anne-Marie Mazza eds., 2006) (recommending a higher standard for biotechnology patent qualification); *see also* FED. TRADE COMM'N, *supra* note 2 (noting concerns for poor patent quality, legal standards, and procedures).

5. Lemley & Sampat, *supra* note 3, at 185 ("The unprecedented modern Supreme Court interest in patent cases and congressional interest in patent reform are both driven in part by the widespread perception that the PTO is acting as a rubber stamp, regularly issuing bad patents that wind up imposing costs on others.").

6. H.R. REP. NO. 112-98, pt. 1, at 38, 40 (2011).

7. *See* Michael D. Frakes & Melissa F. Wasserman, *Does the U.S. Patent and Trademark Office Grant Too Many Bad Patents?*, 67 STAN. L. REV. 613, 618–21 (2015) (summarizing the various explanations for the Patent Office's perceived overgranting tendencies).

8. *See infra* note 19 and accompanying text.

9. Online Appendix tbl.A2. The Online Appendix is available at https://vanderbiltlawreview.org/lawreview/2019/04/online-appendix-to-irrational-ignorance-at-the-patent-office [https://perma.cc/D363-BPAJ].

10. Because patent applications are presumed valid, if examiners are not able to conduct a sufficient search of prior art and articulate a proper basis of rejection over these hours, they are legally expected to allow the application. *See* Sean B. Seymore, *The Presumption of Patentability*, 97 MINN. L. REV. 990, 995–96 (2013) ("An applicant enjoys a presumption of patentability, which means that at the time of filing the application is rebuttably presumed to comply with the utility, novelty, nonobviousness, and disclosure requirements of the patent statute.").

believe they are "fighting for their lives" and are "not [given] enough time to do a proper job."[11] Providing more systematic support, our prior empirical work tested the extent to which patent examiner time allocations are causing examiners to grant invalid patents and found that examiners were indeed granting patents of dubious quality because they are not given sufficient time to review patent applications.[12]

Even in the face of this evidence, however, it is not immediately clear that the solution to the patent quality crisis is to give patent examiners more time. While increasing examiner time allocations will decrease the number of invalid patents issued by the Patent Office, it is possible that the Patent Office is, as Mark Lemley famously wrote, "rationally ignorant."[13] That is, it may be rational for the Patent Office not to screen patent applications too rigorously because there is another institutional player that could weed out bad patents: the courts.

Mark Lemley's seminal article on "rational ignorance" confronts a classic regulatory dilemma: Should society rely on an ex ante, administrative approach to substantive regulation—at a lower cost per unit but at a higher volume of activity—or should society instead regulate ex post via a litigation system—at a higher cost per unit but at a lower level of activity?[14] In the case of patent validity determinations, Lemley favored the latter. He argued that because so few patents are litigated or licensed, it is better to rely on litigation to make detailed validity determinations in those rare instances rather than increasing the resources to the Patent Office to provide more thorough review of all patent applications.[15] Lemley supported his thesis with a cost-

11. MANHATTAN STRATEGY GRP., PATENT EXAMINERS PRODUCTION EXPECTANCY GOALS RE-ASSESSMENT AND ADJUSTMENT STUDY, at D-9 (2010) (on file with author) (quoting patent examiners participating in a focus group).

12. Michael D. Frakes & Melissa F. Wasserman, *Is the Time Allocated to Review Patent Applications Inducing Examiners to Grant Invalid Patents?: Evidence from Micro-Level Application Data*, 99 REV. ECON. & STAT. 550, 560 (2017), *online appendix available at* https://www.mitpressjournals.org/doi/suppl/10.1162/REST_a_00605/suppl_file/REST_a_00605-esupp.pdf [https://perma.cc/R52Y-XKQV] ("Our analysis suggests that as time constraints tighten, examiners will grant some patents that they might have otherwise rejected if given sufficient time.").

13. Lemley, *supra* note 3, at 1531 ("The PTO is rationally ignorant of the objective validity of the patents it examines.").

14. For a discussion of this regulatory dilemma in other contexts, see, for example, Iman Anabtawi & Steven L. Schwarcz, *Regulating Ex Post: How Law Can Address the Inevitability of Financial Failure,* 92 TEX. L. REV. 75 (2013); Brian Galle, *In Praise of Ex Ante Regulation*, 68 VAND. L. REV. 1715 (2015); and John D. Hanson & Kyle D. Logue, *The Cost of Cigarettes: The Economic Case for Ex Post Incentive-Based Regulation*, 107 YALE L.J. 1163 (1998).

15. Lemley, *supra* note 3, at 1497 ("Because so few patents are ever asserted against a competitor, it is much cheaper for society to make detailed validity determinations in those few cases than to invest additional resources examining patents that will never be heard from again.").

benefit analysis wherein he concluded that the costs associated with doubling the Patent Office's hours to review patent applications outweighed the benefits gained by the resulting decrease in the number of invalid patents the Patent Office would issue.[16] Although some of the numbers in his analysis reflect hard data, the dearth of empirical evidence available at the time forced him to make several critical assumptions, including assuming (rather than estimating) how many fewer patents the Patent Office would issue if examiner time allocations were doubled.[17]

While it has been over fifteen years since Lemley wrote his important and widely cited article, the debate on how to best rid ourselves of bad patents continues to rage on. In 2011, Congress enacted the most comprehensive reform bill to the patent system in decades and arguably favored the ex post approach by creating a new adjudicatory tribunal at the Patent Office, wherein third parties can challenge the validity of issued patents.[18] In 2016, for the first time in forty years, the Patent Office began a comprehensive reevaluation of examiner time allocations, arguably favoring an ex ante approach.[19]

The time is ripe to revisit whether the Patent Office is, in fact, "rationally ignorant." Should we increase the resources at the Patent Office in an effort to increase the quality of issued patents, or should we forego those marginal investments and reserve a larger residual role for the courts? This Article begins to answer this question by employing new and rich sources of data along with sophisticated empirical techniques to form novel, empirically driven estimates of the relationships that Lemley was forced to guess in his own analysis.

Armed with these new estimates, this Article demonstrates that the savings in future litigation costs and prosecution expenses[20] associated with giving examiners additional time per application outweigh the costs of increasing examiner time allocations. The efficiency gains from marginal investments at the Patent Office are

16. *Id.* at 1508–10.

17. *Id.* at 1509.

18. *See* Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 6, 125 Stat. 284, 299–313 (2011) (codified as amended at 35 U.S.C. §§ 311–19, 321–29 (2012)) (post-grant review proceedings); *id.* § 18, 125 Stat. at 329–31 (codified as amended at 35 U.S.C. § 321 (2012)) (providing for a transitional program for covered business method patents); *id.* § 10, 125 Stat. at 316–20 (codified as amended at 35 U.S.C. § 4 (2012)) (providing for fee-setting authority); *see also* H.R. REP. NO. 112-98, pt. 1, at 39–40 (2011) (noting that the primary purpose of the America Invents Act is to "improve patent quality").

19. Request for Comments on Examination Time Goals, 81 Fed. Reg. 73,383 (Oct. 25, 2016). Patent examiner time allocations have not been substantially modified since 1976.

20. Prosecution expenses are the costs related to interactions between the patent applicant and the Patent Office.

even greater when considering a range of additional harms that may ensue from the issuance of invalid patents by the Agency. We thus conclude the opposite of Lemley: society would be better off investing more resources into the Agency to improve patent quality than relying on ex post litigation to weed out invalid patents. Given its current level of resources, the Patent Office is not being "rationally ignorant" but, instead, *irrationally ignorant*.

This Article proceeds as follows. Part I provides a summary of our prior empirical work, which found that examiner time allocations were causing examiners to grant invalid patents. This Part concludes by briefly summarizing Lemley's seminal article, *Rational Ignorance at the Patent Office*, highlighting its import in the debate of what to do about bad patents and noting three key assumptions he made in his cost-benefit analysis. Part II comprehensively sets forth the various social benefits associated with increasing the time examiners spend evaluating patent applications, and Part III comprehensively sets forth the various social costs associated with augmenting the time examiners have to review patent applications. In doing so, Parts II and III draw on empirical analyses to provide novel, rigorous estimates of the key relationships comprising this cost-benefit exercise. Part IV then compares the empirical estimates of the costs and savings associated with augmenting examiner time allocations to conclude that the Patent Office is—at least under its current resources—irrationally ignorant. Part IV also highlights the key differences between our findings and Lemley's. We address possible objections in Part V. Finally, Part VI provides some specifics as to how the Patent Office should increase examiner time allocations.

I. BACKGROUND

This Article seeks to provide a take on the classic regulatory question: Should society increase the resources of the Patent Office to weed out bad patents, or should society instead reserve a larger residual role for the courts to invalidate improvidently granted patents? Our approach to this question is to evaluate the merits of increasing the Agency's resources through a particular policy tool: augmenting the amount of time that patent examiners are given to review applications. Section I.A summarizes our prior findings that examiner time allocations induce examiners to grant patents of dubious quality. Section I.B summarizes Lemley's seminal article, *Rational Ignorance at the Patent Office*, highlighting its import in the debate over what to do about bad patents as well as noting three critical assumptions he made in his cost-benefit analysis.

A. Increasing Time Allocations

Why would extending examiners more time to review applications result in the Patent Office issuing fewer legally invalid patents? Patent applications are legally presumed to comply with the statutory patentability requirements when filed. As a result, a patent examiner that is not able to conduct a sufficient search of prior art and articulate a proper basis of rejection during their allotted review time is legally expected to allow the application.[21] Thus, examiners who do not have enough time to properly evaluate applications are likely to grant invalid patents.

Scholars and commentators have long believed that examiners are not given sufficient time to conduct a thorough and comprehensive analysis, though they had generally provided little evidence to support this assertion.[22] To fill this gap, our prior research sought to move beyond anecdotal sentiments and empirically test the extent to which patent examiners' time allocations cause them to grant invalid patents.[23]

The Patent Office sets a patent examiner's time allocation based on two key factors: the technological field in which the examiner is working and her position in the general schedule ("GS") pay scale.[24] A patent examiner in a more complex field is provided more hours to review an application than an examiner of the same GS-level who is working in a less complex field.[25] The higher the pay grade of an examiner within a technology area, the fewer hours the Patent Office extends to that examiner.[26] To demonstrate the degree to which time allocations scale with GS-level changes, we present in Table 1 the examination time expectations facing a patent examiner working in one of the most complex fields, artificial intelligence, and one of the least

21. Seymore, *supra* note 10, at 995–96.

22. Frakes & Wasserman, *supra* note 12, at 550 (summarizing anecdotal evidence that patent examiners are time-crunched).

23. *Id.*

24. U.S. DEP'T COMM., OFFICE OF INSPECTOR GEN., USPTO SHOULD REASSESS HOW EXAMINER GOALS, PERFORMANCE APPRAISAL PLANS, AND THE AWARD SYSTEM STIMULATE AND REWARD EXAMINER PRODUCTION 7 n.6 (2004), https://www.americanbar.org/content/dam/aba/migrated/intelprop/109legis/CommerceDept_IGReportonPTO.authcheckdam.pdf [https://perma.cc/G94G-62T4] ("Expectancy goals vary among examiners and are based on the individual examiner's grade level and the complexity of the technology under review.").

25. Andy Faile, Deputy Comm'r for Patent Operations, Examination Time and the Production System, Presentation at the Santa Clara-Duke Quality Conference (Sept. 9, 2016), http://1x937u16qcra1vnejt2hj4jl-wpengine.netdna-ssl.com/wp-content/uploads/Faile-Examination-Time-and-the-Production-System.pptx [https://perma.cc/4S3N-GKDB].

26. *Id.*

complex fields, compound tools (e.g., a hammer).[27] A promotion to each subsequent pay grade is roughly equated to a 10% to 15% decrease in the number of allocated examination hours.[28] Examiners operating at GS-level 7 are given the greatest amount of time in reviewing patents in compound tools and artificial intelligence—19.7 hours and 45.1 hours, respectively—whereas examiners operating at GS-level 14 are expected to review the same patent in approximately half that time.

In our recent research, we embraced the variation made possible by these schedules to test the link between examination time and the granting practices of examiners. More specifically, we followed individual examiners throughout the course of their careers and tracked the evolution of their examination behavior as they experienced GS-level promotions that diminished the amount of examination time at their disposal.[29] Our methodological design was structured so as to explore this relationship between grant rates and the occurrence of time-allocation-reducing promotions while accounting for the potentially confounding influence of other factors—e.g., increases in examiner years of experience—that may be correlated with such promotions and that may independently affect examiner granting tendencies. Accordingly, in estimating this relationship between GS-levels and grant rates, our underlying regression specifications included a series of fixed effects and other controls: (1) year fixed effects, based on the year in which the application is disposed of, to account for general Patent Office trends and granting practices; (2) examiner experience fixed effects (in two-year bins), to better isolate the time-allocation aspect of GS-level promotions and account for the correlation between GS-levels and experience; (3) examiner fixed effects, to account for the possibility, among other things, that higher GS-level examiners have fundamentally different granting styles from their more junior counterparts; (4) technology-by-year fixed effects, to alleviate concerns that examiners may be reassigned to different technologies as they ascend to higher pay grades and that such reallocation schemes may change over time; and (5) various individual characteristics of the applications, including the entity size of the applicant (large versus small), the length of time between the filing and the disposition of the application, and the foreign priority status of the application (previous filings at the European Patent Office ("EPO") and Japanese Patent Office ("JPO"). Our recent research also included various additional

27. *See* U.S. PATENT & TRADEMARK OFFICE, HOW THE USPTO DETERMINES PRODUCTION FOR USPTO PATENT EXAMINERS (on file with author).

28. *Id.* at 1.

29. Frakes & Wasserman, *supra* note 12, at 550.

empirical exercises to support the proposition that our methodological design captured variations in time allocations—e.g., we tested for and found stronger relationships in the case of time-sensitive bases of rejecting patent applications.[30]

To execute our empirical strategy, we utilized novel data on 1.4 million patent applications disposed of between 2002 and 2012, merged with rich, examiner roster data received from the Patent Office pursuant to a series of Freedom of Information Act ("FOIA") requests.

We found that as an examiner is given less time to review an application—as identified by these time-reducing promotions—the less active she becomes in searching for prior art, the less likely she becomes to make time-intensive rejections, and the more likely she becomes to grant the patent.[31] The magnitude of the result is quite striking. A patent examiner who has been promoted to GS-level 14 has a grant rate that is 13% to 29% higher than it was when she was at a GS-level 7.[32]

TABLE 1: EXAMINATION HOURS ALLOCATED TO EXAMINER AS A FUNCTION OF GS-LEVEL[33]

	(1)	(2)
GS-level	**Compound Tools**	**Artificial Intelligence**
GS-7	19.7	45.1
GS-9	17.3	39.5
GS-11	15.3	35.1
GS-12	13.8	31.6
GS-13	12.0	27.5
GS-13, partial signatory	11.0	25.3
GS-14	10.2	23.4

In the Online Appendix, we update the analysis from this prior work to include five additional years of application data.[34] We find nearly identical results. In the preferred empirical specification that we present, we find a roughly 27% (or 19 percentage-point) higher grant rate for an examiner at GS-level 14 relative to GS-level 7.[35] Figure 1 uses these updated results to plot the relationship between a given

30. *Id.*
31. *Id.*
32. *Id.*
33. *Id.* at online app. at 2–3 tbl.A1.
34. *See* Online Appendix, *supra* note 9; *see also* Frakes & Wasserman, *supra* note 12.
35. *See infra* Figure 1.

examiner's grant rate and the occurrence of each of the indicated GS-level promotions, wherein GS-level 7 serves as the omitted reference group and wherein the indicated relationships partial out the influence of those other factors mentioned above (e.g., examiner experience-level bins).[36] As Figure 1 demonstrates, examiner grant rates ascend strongly and monotonically with each GS-level promotion. In addition to the rich level of controls that we include in the regression design underlying this figure, the analysis also supports a causal interpretation of the observed pattern in light of certain institutional features of the Patent Office. Mainly because patent applications are randomly assigned to examiners within their technological groups, there is no reason to believe that examiners at higher GS-levels are being assigned more patent-worthy applications than examiners at lower GS-levels.[37]

Our updated analysis implies that if examiners are given double the amount of time to review applications, the Patent Office's overall grant rate would fall by roughly 19 percentage points, amounting to roughly eighty thousand fewer patents issued per year. What is the nature of these eighty thousand patents? Are they valid or invalid? If we were to expand time allocations so as to knock out patents, we would hope that the affected patents would indeed be invalid patents. Fortunately, our previous study was able to explore the nature of those patents issued on the margin as a result of binding time constraints.[38] To do so, we relied on the fact that many U.S. applicants likewise file for patent protection with the EPO and the JPO, two offices that are known to invest substantially more resources per application in the examination process while having essentially similar patentability standards.[39] Accordingly, we considered the sample of issued patents in which the relevant U.S. applicant likewise sought protection at the EPO and the JPO and used outcomes at these foreign offices as a benchmark—albeit an imperfect one—to assess what the outcome at the U.S. Patent Office would have been (at least generally speaking) if the U.S. examiners were given more time and resources to determine

36. Frakes & Wasserman, *supra* note 12, at 556.

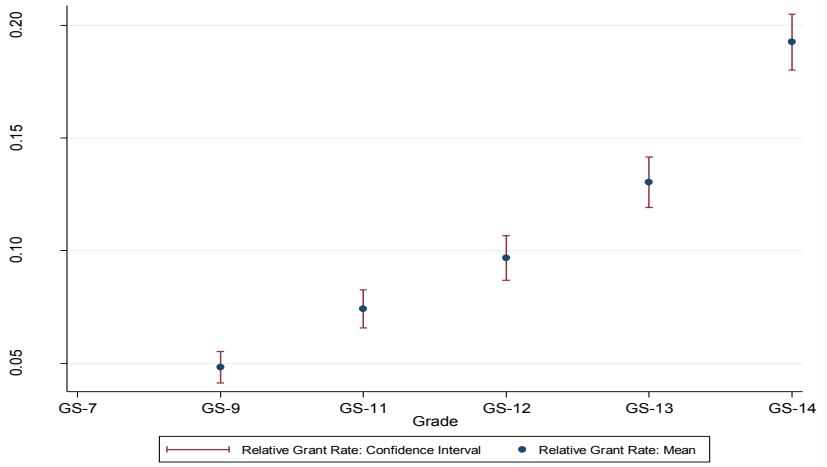
37. A recent paper by Cesare Righi and Timothy Simcoe documents evidence of examiner specialization within technology-group assignments, as well as specialization within technology subgroups. Cesare Righi & Timothy Simcoe, *Patent Examiner Specialization*, 48 RES. POL'Y 137, 141 (2019). However, Righi and Simcoe's analysis finds "little evidence" suggesting that applications are assigned to examiners based on the importance or claim breadth of the applications or on their patent worthiness. *Id*. at 147.

38. Frakes & Wasserman, *supra* note 12, at 553.

39. Pierre M. Picard & Bruno van Pottelsberghe de la Potterie, *Patent Office Governance and Patent System Quality*, 104 J. PUB. ECON. 14, 16–17 (2013) (presenting "stylized facts on differences between the U.S. Patent and Trademark Office (USPTO), the European Patent Office (EPO), and the Japan Patent Office (JPO)").

the patentability of the relevant invention.[40] We found evidence that the promotions of interest in our study were associated with a reduction in the frequency by which the inventors of U.S.-issued patents are successful in securing patent protection for the relevant inventions at the EPO and the JPO.[41] The implication of this finding is that the marginal patents being issued as a result of binding time constraints are indeed of questionable legal validity.

FIGURE 1: RELATIONSHIP BETWEEN EXAMINER GS-LEVELS AND GRANT RATE



This Figure presents results from a regression of the incidence of a granted application on dummy variables representing each GS-level between 7 and 14. The dummy variable for GS-level 7 is omitted, representing the reference group. The vertical bars represent 95% confidence intervals for the estimated coefficients. The underlying regression producing this relationship accounts for fixed differences in granting practices across technology groups, across examiners, and across years, while also controlling for examiner experience levels. Further specifics are provided in the Online Appendix.[42]

40. To assess the quality of these marginal patent issuances, we consider the full sample of patents that were issued in the United States and also sought protection in the EPO and the JPO and then estimate how the mean incidence of such patents likewise being granted by the EPO (and/or the JPO) changes as examiners experience GS-level promotions that reduce the amount of examination time available to them. Consistent with expectations, we find that relative to the patents issued at GS-level 7, the patents issued at GS-level 14 are seven percentage points (or roughly sixteen percent) less likely to be allowed by both the EPO and the JPO (when using success at both foreign offices to signify the strongest benchmark of quality). Frakes & Wasserman, *supra* note 12, at 560.

41. *Id.*

42. Online Appendix, *supra* note 9, at 2–4.

In summary, our results from our prior research suggest that examiners are facing binding time constraints and that these time constraints are inducing examiners to grant invalid patents.[43]

B. The Rationally Ignorant Patent Office

Despite the existence of this compelling empirical evidence, it is not immediately clear that the solution to the patent quality crisis is to increase the time allocations of examiners. The Patent Office is not the only institution in the patent system that is capable of removing bad patents. Patent examiners, the adjudicatory board at the Patent Office, and the federal courts are all tasked with applying the patentability standards and assessing the validity of inventions seeking patent protection. In *Rational Ignorance at the Patent Office*, Mark Lemley argued that it is rational for the Patent Office not to screen patent applications too rigorously.[44] The key to his argument is that most bad patents are not economically significant because, like patents generally, few bad patents are litigated or licensed.[45] Armed with this insight, he contended that litigation over a few economically valuable patents ex post may be more cost effective than a thorough examination of all patents ex ante.[46] Despite the power of this conceptual observation, it is ultimately an empirical question whether the ex ante approach is in fact less cost effective than simply relying on the ex post litigation alternative.

Lemley, recognizing this, attempted to support his "rational ignorance" contention with a cost-benefit analysis. During this calculation, he limited his consideration of costs and benefits to the following: private costs of prosecuting patents, annual returns of licensing patents, and total litigation costs.[47] Lemley concluded that the costs associated with doubling the Patent Office's hours to review patent applications outweigh the social benefits gained by the resulting decrease in the number of invalid patents the Patent Office would issue.[48] Although some of the numbers in his analysis reflect hard data, empirical evidence on a number of the relationships important to his analysis was unavailable at that time. As a result, he was forced to

43. Frakes & Wasserman, *supra* note 12, at 554–55.

44. Lemley, *supra* note 3, at 1496–97 ("Because so few patents are ever asserted against a competitor, it is much cheaper for society to make detailed validity determinations in those few cases than to invest additional resources examining patents that will never be heard from again.").

45. *Id.*

46. *Id.* at 1496.

47. *Id.* at 1508–10.

48. *Id.* at 1508.

guess the magnitude of certain key parameters of this cost-benefit analysis, including the following:[49]

- First, he assumed that doubling the time allocated to patent examiners would result in a ten percent drop in the number of invalidly issued patents.[50]
- Second, he assumed that a ten percent drop in the number of improvidently issued patents would correspond with a 10% drop in litigation costs.[51]
- Third, he assumed that doubling patent examiners' time allocations would result in a fifty percent increase in the attorney's cost of prosecuting a patent application.[52]

The influence of Lemley's contention that the Patent Office is, and ought to be, "rationally ignorant" is incontestable. Lemley is the most frequently cited scholar in the field of intellectual property[53] and *Rational Ignorance at the Patent Office* is his most cited article.[54] Given the influence of the "rational ignorance" concept, it is unsurprising that we are not the first to revisit the idea. Perhaps most notably, Arti Rai has argued that while there is much to admire about Lemley's article, it suffers from several limitations.[55] Rai noted, as we do above, that Lemley's cost-benefit analysis is based on "a few empirical assertions" and that he had to "assume" or "guess" critical relationships.[56] She then cogently argued that the cost-benefit analysis of whether the time allocations of patent examiners should be increased should include a fuller account of the costs associated with the persistence of invalid patents—i.e., the benefits that would ensue from eliminating such patents—than Lemley set forth in his article.[57] Shuba Ghosh and Jay

49. *Id.* at 1511.

50. *Id.* at 1508.

51. *Id.* at 1509.

52. *Id.* at 1508.

53. Brian Leiter, *Ten Most-Cited Law Faculty in the United States for the Period of 2013-2017*, BRIAN LEITER'S L. SCH. REP. (Aug. 14, 2018), http://leiterlawschool.typepad.com/leiter/2018/08/ten-most-cited-law-faculty-in-the-united-states-for-the-period-2013-2017.html [https://perma.cc/72AF-WCJS]. Mark Lemley is ranked fourth and also happens to be the only law professor included on the list who writes in intellectual property, as well as the youngest law professor included on the list. *Id.*

54. *Mark Lemley*, GOOGLE SCHOLAR, https://scholar.google.com/citations?user=dF7HJ18AAAAJ&hl=en (last visited Apr. 3, 2019) [https://perma.cc/AP9Z-82EJ] (noting that *Rational Ignorance at the Patent Office* has received over 1,200 citations).

55. Arti K. Rai, *Engaging Facts and Policy: A Multi-Institutional Approach to Patent System Reform*, 103 COLUM. L. REV. 1035, 1081 (2003) ("Ultimately, however, the analysis suffers from several limitations.").

56. *Id.* at 1080–81.

57. *Id.* at 1081–84. Rai also provides an interesting discussion on how post-grant proceedings could alter Lemley's cost-benefit analysis. Given that Rai wrote her article in 2003, her discussion

Kesan have made a similar argument, delineating in detail the various costs of bad patents that Lemley did not include in his analysis.[58] We agree with this contention and discuss how a broader spectrum of costs and benefits shapes and influences our analysis below. Notably, neither Rai nor Ghosh and Kesan attempted their own calculations to determine whether the social benefits of providing more resources to the Patent Office outweigh the social costs of doing so, noting the difficulties with such an endeavor.[59]

Because the resolution of this debate ultimately rests on an empirical evaluation of the costs and benefits of investing more in ex ante examination review, this Article, similar to Lemley's, confronts that cost-benefit exercise. Unlike Lemley, however, who had to guess each of the three above-mentioned critical relationships, we are able to provide empirically driven estimates of these relationships by utilizing rigorous empirical methodologies drawn from our own prior work and from that of others. Given the import of the "rational ignorance" concept on the debate surrounding how to increase patent quality, it is important to revisit the idea bringing to bear new empirical data and novel empirical methods to the concept. In doing so, we hope to provide a more accurate picture of the costs and benefits associated with increasing the resources of the Patent Office to weed out bad patents. The next Part begins this difficult task.

II. SAVINGS ASSOCIATED WITH DECREASING THE ISSUANCE OF INVALID PATENTS

Should we increase the resources of the Patent Office to help solve the patent quality crisis or rely on litigation to weed out bad patents? To answer this question, we want to know whether spending one dollar on increasing the resources at the Agency would save more than one dollar on the back end. That is, are the marginal benefits associated with allowing fewer invalid patents (due to the additional

of post-grant proceedings assumes a structure like the European model—i.e., a continuation of the initial examination of patent application. This model, however, does not follow inter partes review procedures, which are the dominant mode of PTAB adjudication.

58. Shubha Ghosh & Jay Kesan, *What Do Patents Purchase? In Search of Optimal Ignorance in the Patent Office*, 40 HOUS. L. REV. 1219, 1227 (2004). Ghosh and Kesan also argued that litigation would not perfectly eliminate all invalid patents. *Id.* at 1229. Ghosh and Kesan provide numerous reasons why invalid patents that are imposing harm on society may never be challenged in litigation. *Id.* at 1229–35. We see this argument as a corollary of their first point. To the extent that invalid patents will never be challenged in litigation, it is important to more fully understand the costs they impose on society.

59. *Id.* at 1228. Recognizing the difficulties associated with such a task and the lack of empirical data, Gosh and Kesan found that "it is difficult to quantify meaningfully the magnitude of the total social costs of bad patents." *Id.*

dollar spent on Agency resources) greater than the marginal costs of providing examiners with more time to evaluate a patent application? If the answer is yes, then more savings are recouped than spent, and society should devote more resources to the Patent Office to increase the quality of examinations. If the answer is no, then society should not increase the resources to the Agency but instead continue to rely on litigation at its current level to weed out bad patents.

To begin to tackle this calculation, the potential savings associated with increasing resources to the Patent Office and the costs associated with decreasing the number of invalid patents issued by the Agency must be understood. Before laying out the structure of this analysis, however, we note that while we desire to explore the returns to an additional dollar of spending at the Agency, our analysis below will actually evaluate the benefits arising from a larger marginal investment at the Patent Office. In order to make a direct comparison with Lemley, we will estimate the costs and benefits associated with a doubling of the amount of hours given to examiners, an investment in examination resources that surely exceeds one dollar. Nonetheless, we do not believe that our conclusion hinges on whether we approach this from the perspective of adding one more dollar to examination review or whether we envision doubling the time allotted for examination review. After all, in estimating the costs associated with doubling examination time, we conservatively assume some degree of overhead costs, hiring costs, and other costs associated with hiring and staffing more examiners. We would arguably not need to assume as many indirect costs of this nature if we just hypothesized adding a marginal dollar to examination review. In this case, whatever conclusion we reach as to the merits of more ex ante investment with a doubling-of-hours approach should only generalize if we instead assessed the merits of a smaller, more marginal investment at the Patent Office. On the savings side, we confront this scaling concern somewhat directly with our empirical analysis. As discussed below, we find similar savings estimates whether we estimate empirical specifications that impose a linear relationship between time and litigation events or whether we estimate specifications that take a more nonparametric approach that does not assume any such linearity. Accordingly, when thinking about the savings side of our analysis, we also find no reason to believe that our results would not scale with the assumed size of the marginal investment in the Agency.

This Part begins the cost-benefit calculation by sketching the savings associated with increasing the time an examiner spends reviewing a patent application. The potential savings from issuing fewer invalid patents are numerous. The harms associated with bad

patents include supracompetitive pricing (and the resulting reduction in access to the patented inventions),[60] the preclusion of competitors from entering the affected markets,[61] and the stunting of follow-on innovation.[62] Invalid patents can also be utilized to opportunistically extract licensing fees from innovators,[63] inhibit the ability of startups to obtain venture capital,[64] impose wasteful litigation costs on society, and needlessly tax our already overburdened judiciary.[65] Unfortunately, it is nearly impossible to quantify the vast majority of these harms with any certainty.

As a result, this Part focuses on the potential savings associated with litigation savings, the benefit for which the most empirical data is available. It then considers whether doubling the time allocations of examiners results in decreasing prosecution expenses and concludes by considering other potential savings associated with doubling patent examiner time allocations.

A. Litigation Savings

This Section begins by outlining the litigation savings associated with doubling the time given to patent examiners to review applications. Determining the potential benefits associated with increasing Patent Office resources requires knowledge of the following

60. Not surprisingly, the patentability standards reflect a careful balance between encouraging innovation and drains on consumer welfare. In order for an invention to be patent eligible, it must be both new and represent a nontrivial advancement over the current state of the art. 35 U.S.C. §§ 101, 103 (2012). If an invention was obvious to the person of ordinary skill in the art or was already in the public domain, the invention would have likely arisen without the patent incentive. *See id.* § 103. In contrast, an invention that represents a significant advancement in the art may not have arisen but for the patent inducement.

61. *See* FED. TRADE COMM'N, *supra* note 2, at 3 (noting that allowing patents on obvious inventions can thwart competition); Christopher R. Leslie, *The Anticompetitive Effects of Unenforced Invalid Patents*, 91 MINN. L. REV. 101, 119–25 (2006) (discussing the chilling effect invalid patents have on other potential innovators).

62. Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698, 699 (1998); Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and the Patent Law*, 5 J. ECON. PERSP. 29, 32 (1991) (noting that overly broad patent protection "can lead to deficient incentives to develop second generation products").

63. *See* Leslie, *supra* note 61, at 104.

64. *See* FED. TRADE COMM'N, *supra* note 2, at 8 ("The threat of being sued for infringement by an incumbent [patent holder]—even on a meritless claim—may 'scare . . . away' venture capital financing." (quoting public comment of Joshua Lerner, Professor, Harvard Business School)).

65. *See In re* Ciprofloxacin Hydrochloride Antitrust Litig., 363 F. Supp. 2d 514, 544 (E.D.N.Y. 2005) ("Dow alleged that Exxon had threatened to sue actual and prospective Dow customers for patent infringement, even though Exxon allegedly had no good-faith belief that Dow infringed the patent when Exxon made the threats and had allegedly obtained the patent by inequitable conduct." (citing Dow Chem. Co. v. Exxon Corp., 139 F.3d 1470, 1472, 1477 (Fed. Cir. 1998))); Leslie, *supra* note 61, at 125–27 (noting how further innovation may be stymied).

three pieces of information: (1) the costs associated with litigating patents, (2) how many fewer patents would be issued if the Patent Office increased the time allocations of examiners, and (3) the relationship between the amount of time extended to an examiner to review an application and the number of times any patent resulting from that application might one day become the subject of litigation. While Lemley was forced to guess these latter two relationships, we draw from sophisticated empirical methodologies to provide empirically driven estimates of them. In doing so, we hope to provide a more accurate picture of the savings associated with the Patent Office issuing fewer bad patents.

Before proceeding to the details of our analysis, we should note that the simple ex ante versus ex post (that is, Agency versus courts) debate is more complicated now than in 2001, when Lemley wrote his seminal article. In 2012, the Patent Trial and Appeal Board ("PTAB"), which provides a court-like option at the Agency, was introduced into the patent system.[66] More specifically, PTAB provides for a robust adjudicatory pathway in which third parties can challenge the issuance of a patent at the Patent Office.[67] The analysis below incorporates consideration of PTAB into our cost-benefit calculation.

This proceeds as follows. First, we provide a summary of patent-litigation expenses in federal courts and in PTAB proceedings. Second, we delineate the theory of why increasing the time examiners review patent applications would lead to a savings in litigation costs. Third, we empirically estimate how much litigation savings in federal courts may ensue from a doubling of the amount of time allocated to examiners to review applications. Fourth, we repeat the exercises from Section II.A.3 but focus on the litigation savings associated with PTAB adjudication.

1. Background on Litigation Expenses

Potentially substantial litigation savings may ensue by preventing invalid patents from issuing in the first place. After all, patent litigation in federal court is very expensive. The American Intellectual Property Law Association ("AIPLA") reports that when $10 million to $25 million of damages are at risk, the median cost of patent litigation is $1 million for each side through the end of discovery and

66. Leahy-Smith America Invents Act, Pub. L. No. 112–29, § 7, 125 Stat. 284, 313–15 (2011); *see also* Melissa F. Wasserman, *The Changing Guard of Patent Law:* Chevron *Deference for the PTO*, 54 WM. & MARY L. REV. 1959, 1981–88 (2013) (describing the court-like aspects of these new proceedings).

67. *See* Wasserman, *supra* note 66, at 1981–88 (describing the procedural details associated with PTAB adjudication).

$2 million for each side through trial and appeal.[68] These litigation costs scale upward and downward depending on the amount at risk. For instance, the median cost of patent litigation when more than $25 million is at risk to each side is $1.7 million through the end of discovery and $3 million through trial and appeal.[69]

Federal district courts, however, are no longer the only venue in which the validity of issued patents can be challenged. Since 2012, issued patents can also be challenged before PTAB.[70] These new proceedings, which provide a robust pathway for third parties to challenge the validity of issued patents at the Agency, are supposed to provide a cost-effective alternative to challenging patents in federal courts.[71] Reflecting this intention, these new proceedings share a host of features that mimic certain characteristics of a civil trial.[72]

While Congress intended for PTAB to act as a substitute to federal district court litigation, suits may be brought in both venues; empirical evidence to date suggests that the overwhelming number of patents that are subject to a petition before PTAB are also subject to district court litigation.[73] Although PTAB has proved a popular venue in which to challenge issued patents, the vast majority of patents whose validity is challenged are litigated only in Article III courts.[74] The costs associated with challenging patents in a PTAB proceeding are significant, even though they are lower than the expenses associated with federal court litigation. The AIPLA reports the median cost of post-grant proceedings before the Patent Office to each side is $200,000

68. AM. INTELLECTUAL PROP. LAW ASS'N, 2017 REPORT OF THE ECONOMIC SURVEY 41 (2017) [hereinafter AIPLA 2017 REPORT]. We acknowledge that there may be some noise in the AIPLA-reported numbers, but we have no reason to believe that the AIPLA-reported numbers are biased in one direction or another. We also note that Mark Lemley also utilized AIPLA-reported numbers in his cost-benefit analysis. *See* Lemley, *supra* note 3, at 1502.

69. AIPLA 2017 REPORT, *supra* note 68, at 41.

70. Leahy-Smith America Invents Act § 7.

71. The House Report on the America Invents Act ("AIA") states that the Act intended to "convert[ ] inter partes reexamination from an examinational to an adjudicative proceeding" while establishing a new agency procedure known as post-grant review that "would take place in a court-like proceeding." H.R. REP. NO. 112-98, pt. 1, at 46, 68 (2011).

72. Wasserman, *supra* note 66, at 1981–88. Perhaps most saliently, the Patent Act requires these new administrative hearings to take place through an adversarial, court-like hearing in which parties are entitled to oral arguments and discovery. *Id*.

73. Saurabh Vishnubhakat, Arti K. Rai & Jay P. Kesan, *Strategic Decision Making in Dual PTAB and District Court Proceedings*, 31 BERKELEY TECH. L.J. 45, 81 (2016) (finding that seventy percent of patents associated with a petition before PTAB are also subject to federal court patent litigation).

74. *Id.* at 69 (finding approximately eighty-five percent of patents (11,787 out of 14,218 cases) whose validity are challenged are subject to federal district court litigation only).

through the end of motion practice, $250,000 through the PTAB hearing, and $350,000 through appeal.[75]

Though these expenses are considerable, patent challenges—whether brought in federal district court or PTAB proceedings—are relatively rare. Only roughly 17,000 of the issued patents in our sample of over 2.7 million over a sixteen-year period were asserted in federal court. Of course, even if ex post litigation is rare, meaningful savings could still be achieved from further embracing an ex ante approach if the amount of litigation that is forestalled in the process is large enough. Before addressing the empirical methodology underlying our attempt to determine the amount of litigation savings, this Article addresses why, conceptually, more investment at the examination stage may lead to less litigation in the first place.

2. Why Greater Examination Scrutiny May Lead to Litigation Savings

To begin this conceptual discussion, recall that the number of patents issued by the Patent Office may be expected to go down if examiners are given more time, as examiners may be better able to determine and articulate a basis to reject the invalid application. As discussed in Section I.A, we estimate that a doubling of the amount of time given to examiners will lower the Patent Office's grant rate by roughly 27% (or by 19 percentage points).[76] Importantly, our prior research also demonstrates that the forgone issuance of patents are likely of dubious quality. Considering the present level of application disposals per year, this suggests that upward of eighty-one thousand fewer patents would be allowed each year if examiners were given twice as much time to review applications.

Now, why might we see litigation savings following these reductions in the number of patents issued? The first reason is perhaps self-evident: with fewer patents in issue, there is less opportunity for dispute to arise at all—whether based on infringement or validity. As such, we may see less litigation. Second, as discussed in Section I.A, because the patents that would cease to issue upon doubling examiner time allocations are likely to be of dubious quality, we may see a reduction in litigation to the extent that at least some patent litigation is driven by challenging the validity of low-quality patents. These may be lawsuits that would have otherwise commenced as declaratory judgment actions by non-patent holders wishing to invalidate another's

75. AIPLA 2017 REPORT, *supra* note 68, at 51.

76. Online Appendix, *supra* note 9, at 2–4.

patents or as infringement actions by patent holders in the shadow of strong threats to file declaratory judgment actions by the non-patent holders. They may also represent lawsuits that would have otherwise been filed by a subset of non-practicing entities that have acquired a pool of low-quality patents and that seek nuisance settlements.[77]

3. Empirical Investigation of the Link Between Examination Time Allocations and Litigation Savings

Moving from theory to empirics, this Section seeks to estimate just how much litigation savings may ensue from doubling the amount of time allocated to examiners to review applications. To approach this question, we start by collecting data on individual patent applications from the Patent Office's Patent Application Information Retrieval ("PAIR") database, covering over 3.9 million utility patent applications filed on or after March 2001 and reaching a final disposition by May 2017—i.e., excluding ongoing applications. Importantly, for each application, we possess information on the name of the examiner primarily charged with reviewing the application.[78] To these data, we merge information on the future litigation (and PTAB) outcomes of those applications that culminate in patent issuance. For these purposes, we collected data on all patent lawsuits filed since January 2001 from the Lex Machina database. We organize these data by patent number and determine the number of times each such patent is asserted in litigation. We do the same using data on PTAB filings that were graciously provided to us by Arti Rai and Jacob Sherkow. To these data, we also merge information on the GS-level of the associated examiner at the time of application disposition, which is necessary to determine the examiner's time allocation. Information on the GS-level for each of the roughly twelve thousand examiners represented in our

77. This discussion has focused on litigation savings due to a reduction in the volume of issued patents, especially legally invalid patents. Theoretically, similar results may also arise from effects of time-allocation expansions on the scope of claims allowed by patent examiners. Imagine an application that an examiner would have allowed anyway, regardless of the time extended to her. With more time to review the application, the examiner may have further scrutinized the breadth of the claim scope sought by the applicant—e.g., she would have rejected a patent covering a flying car but would have allowed a patent covering a fusion-powered flying car. As the scope of claims issued by the Patent Office narrows, we may likewise see less litigation to the extent that some amount of litigation is also originated in part due to a desire to challenge the validity of patents in issue in light of the inappropriate scope of the claims (or originated in part to seek a nuisance settlement based on the assertion of a low-quality patent with excessive scope).

78. We treat the individual who did the majority of work on the application as the examiner charged with reviewing that application—the nonsignatory examiner, when both a nonsignatory and an examiner with signatory authority are associated with an application, or the signatory examiner, when only one examiner is associated with an application.

analytical file come from an examiner roster indicating GS-level promotion dates for each examiner, which we received pursuant to a FOIA request.

With these data in place, we then seek to estimate empirical specifications capturing the relationship between the number of times that a given patent application is ultimately asserted in court (or in a PTAB proceeding) and the number of hours extended to the examiner to review the given application. This estimate will capture both of the theorized mechanisms regarding the link between time allocations and litigation savings: (1) reduced litigation due to the fact that time allocation expansions will decrease the overall number of issued patents and thus decrease the baseline probability of any dispute arising and (2) reduced litigation due to the fact that time allocation expansions will decrease the number of invalid patents that issue and thus decrease litigation activity that is specifically stimulated by the issuance of invalid patents. Since our goal is to understand how doubling time allocations for all examiners may lead to a reduction in overall litigation, we attempt to capture both such mechanisms by estimating the relationship in question using a sample of filed applications (as distinct from issued patents) as the baseline sample.

To evaluate how examination time may affect litigation outcomes, it is necessary to draw on some degree of variation in examination time allotments. To understand where this variation comes from, remember that time allocations are a function of two factors: the examiner's GS-level and the technology group in the Patent Office to which the examiner is assigned. Given this basic structure, we seek to determine how the litigation outcomes for the underlying applications change as examiners ascend through the GS scale. We capture this relationship by regressing the number of times the application is asserted in litigation on dummy variables for the different GS-levels—e.g., a dichotomous variable indicating whether the associated examiner is at GS-level 7, a dichotomous variable indicating whether the examiner is at GS-level 9, and so forth. Specifically, given the rarity and count-like structure of the litigation outcomes (i.e., measures that take on integer levels greater than or equal to zero), we do not estimate Ordinary Least Squares regressions but instead estimate conditional negative binomial regression models. Within this regression framework, we include fixed effects for the technology group to which the examiner is assigned, such that we account for fixed differences in litigation frequencies across technologies. In essence, this approach compares litigation outcomes across GS-levels *within* a given technology group. Since time allocations are a function of GS-level and

technology, this forces us to focus on the variation in time allocations that arises solely through variation in GS-levels.[79]

Of course, one may be concerned that changes in GS-levels may be correlated with other factors that likewise change over time and affect litigation outcomes, confounding any ability to suggest that the relationship we find between GS-levels and litigation rates can be attributed to time-allocation effects. It is thus important to account for as many such factors as possible. Accordingly, we also include a series of fixed effects for the following factors: (1) the year in which the application is disposed of, to account for changing litigation patterns over time, as the quality of the issued patent, and general economic conditions; (2) the experience level of the examiner (in two-year bins), to better isolate the time-allocation aspect of GS-level promotions and account for the correlation between GS-levels and experience (and thus account for the fact that issued patent quality may change with examiner experience for independent reasons);[80] (3) the year in which the examiner joined the Patent Office, to account for changes in the conditions under which examiners were trained, which may have long-lasting impacts on the quality of their reviews throughout their career;[81] and (4) the ultimate tenure of the examiner at the Patent Office—i.e., the total number of years the relevant examiner ultimately spends with the Patent Office—to account for the fact that examiners that leave the Agency at different stages to pursue outside opportunities may differ in their fundamental examination quality. [82]

We focus our estimation sample on those patent applications that were disposed of prior to 2014. We exclude dispositions subsequent

79. If we were to try to identify the effect of hour allocations by isolating variations in time allotment across technology groups, it would be very difficult to separate the effect of time allotments themselves from differences in litigation (and other) outcomes due to the nature of the different technologies. We prefer instead to focus on exploring dynamics entirely within given technological groups.

80. We organize experience groups into two-year bins following the methodological insight of our previous research, Frakes & Wasserman, *supra* note 12, at 550, given the perfect identity between hiring-year cohort effects, year effects, and experience effects that would otherwise occur if they were all grouped at the same level (i.e., experience = cohort + time).

81. Michael D. Frakes & Melissa F. Wasserman, *Patent Office Cohorts*, 65 DUKE L.J. 1601, 1602, 1605 (2016).

82. In Table 2, we do not include examiner fixed effects—i.e., do not account for fixed differences in litigation frequencies across every single examiner—because including examiner effects and technology-group fixed effects in a conditional negative binomial regression with over three million observations represents a rather cumbersome estimation exercise. Nonetheless, in our prior research on grant rates as the key outcome to be measured, we found that accounting for disposition year effects, examiner hiring year effects, examiner tenure effects, and examiner experience effects (all of which we include in the present Article) leads to estimates that are virtually identical to estimates that include examiner fixed effects. Frakes & Wasserman, *supra* note 12, online app. at 8.

to this point as there is generally a notable gap in time between when patents issue and when we observe assertions in federal court. Since the goal of the analysis is to understand what determines federal court outcomes, we do not wish to attenuate our results by including a set of applications for which there is not sufficient time to observe litigation outcomes. This brings the size of the analytical regression sample down to roughly 2.6 million applications. Nonetheless, we stress that the regression results are virtually identical when we instead include all 3.9 million applications, including those disposed of from 2014 to 2017. To be clear, this restriction of excluding applications disposed of after 2014 relates only to the sample of applications whose time allocations we are evaluating. For the litigation outcomes, we are continuing to use data as near to the present as possible. In this way we are, for instance, including applications disposed of in 2013 to see if they are litigated by 2017.[83]

We present the results of this exercise in Column 1 of Table 2. The reported coefficients are to be interpreted as incidence rate ratios ("IRR"). For instance, the estimated IRR of 1.26 for the GS-level 9 coefficient suggests that the applications reviewed by GS-level 9 examiners are litigated at 1.26 times the rate of applications reviewed by the reference group—i.e., GS-level 7 examiners. In other words, the GS-level 9 applications are litigated at a 26% higher rate. Importantly, we find that the degree of litigation rises monotonically with GS-level, suggesting that litigation becomes more likely the more that examination times are cut by the Patent Office. For purposes of this Article, this pattern of results suggests that litigation becomes less likely as examination times are expanded.

As noted above, to facilitate a comparison of our analysis with that of Lemley's, we examine the litigation savings stemming from doubling the examination time allotments. Considering that examination time falls by almost exactly half as examiners ascend from GS-level 7 to GS-level 14, comparing the litigation outcomes between these two levels provides us with an opportunity to explore the effect of cutting—or doubling, when considering the relationship in reverse—the assigned examination time in half. Given that GS-level 7 is the reference category in Table 2, it is relatively straightforward to make this comparison—that is, to simply observe the estimated coefficient of the GS-level 14 dummy. Doing so suggests that if examination time is cut in half, the number of times an application is ultimately asserted in

83. For the reasons that we discuss in the Online Appendix, we drop GS-level 5 and GS-level 15 examiners from our analysis, though we note that this decision has little to no bearing on our results and the conclusions we reach. Online Appendix, *supra* note 9, at 3.

litigation increases by roughly 78%, as suggested by the IRR of 1.78. If we consider a move in the reverse direction—i.e., doubling the amount of examination time—an IRR of 1.78 suggests that moving from GS-level 14 to GS-level 7 hours brings the incidence rate from a normalized rate of 1.78 to the reference rate of 1.0, representing a roughly 44% decrease in the incidence rate. In other words, by doubling the amount of examination time, we may expect to observe a 44% reduction in the rate that an application will be expected to result in a patent that is asserted in litigation (relative to the baseline mean).[84] This may be due to the fact that the expansion in examination time leads to the issuance of fewer patents overall and fewer invalid patents in particular.[85]

84. In unreported regressions, we also estimate specifications where we limit the sample to issued patents. In this alternative approach, we estimate a similar pattern of increasing rates of litigation as examiners ascend GS-levels. This implies that the results from Table 2 may, in part, reflect a response to the second mechanism identified above. That is, we do not merely see more litigation as examination time decreases because there are more patents issued and thus more opportunities to litigate. We also find that those legally invalid patents being issued on the margin in connection with GS-level changes are more likely to be asserted in court relative to the average issued patent. In other words, our findings suggest that legally invalid patents do attract more litigation, in which case decreasing the number of legally invalid patents via enhanced time allocations to examiners may further reduce litigation frequencies.

85. Again, this may also be due to a response to increased time allocations in which examiners issue patents with narrower scopes. On a final note, this 44% estimate remains nearly the same when taking an alternative approach in which we simply assign a variable to each application equal to the number of hours allotted to the associated examiner based on the GS-level and technology group of that examiner. We then estimate the same negative binomial regression model as above but replace the series of GS-level dummy variables with this sample-hours variable. We leave this as a robustness exercise in that it is less flexible and more parametric than the preferred approach from Table 2 as it fits a linear hours relationship—e.g., it implicitly assumes, for instance, that a move from six to seven hours of time allocation will have the same impact as a move from thirty-two to thirty-three hours. Also, this approach will simulate the effect of increasing the number of hours allocated by the average hours allotment over our sample, 17.9 hours, even though this will not represent a true doubling for above- and below-average hour allotment technology groups. The GS-level 7 and GS-level 14 comparison by design will simulate the effect of doubling hour allotments for all technology groups. Nonetheless, it is encouraging that these approaches yield similar results.

TABLE 2: RELATIONSHIP BETWEEN EXAMINER GS-LEVELS AND THE NUMBER OF TIMES INDIVIDUAL APPLICATIONS ARE ASSERTED IN LITIGATION AND INSTITUTED IN PTAB PROCEEDINGS: NEGATIVE BINOMIAL REGRESSION RESULTS

	(1)	(2)
	Dependent Variable: Number of Times Ultimately Asserted in Litigation	**Dependent Variable: Number of Times Ultimately Instituted in PTAB Proceeding**
Incident Rate Ratios for:		
(Omitted: GS-7)		
GS-9	1.26**	2.18
	(0.13)	(1.06)
GS-11	1.29***	3.41***
	(0.14)	(1.60)
GS-12	1.36***	2.91**
	(0.15)	(1.38)
GS-13	1.59***	3.12**
	(0.17)	(1.48)
GS-14	1.78***	3.55***
	(0.19)	(1.68)
N	2,631,302	2,229,496

Estimates marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively. Standard errors are reported in parentheses and are clustered to correct for autocorrelation within given examiners over time. Each observation is a given application from the PAIR database that reached a final disposition and that was published in the PAIR records between March 2001 and December 2014. Litigation outcomes are tracked through 2017, however, and PTAB outcomes are tracked through March 2016. The underlying negative binomial regressions producing these relationships account for fixed differences in litigation (or PTAB) outcomes across technology groups and across year, while also controlling for the entity size of the applicant and a range of examiner characteristics: experience (at the time of application disposition), ultimate tenure at the Patent Office, and hiring year. Reported coefficients are to be interpreted as incidence rate ratios, as discussed in the main text. Further specifics are provided in the Online Appendix.

This estimate allows us to turn to determining how much litigation savings may ensue from a doubling of examination time. For these purposes, we use information on the cost of patent litigation from the AIPLA, capturing costs associated with outside and local counsel; paralegal services; travel and living expenses; fees and costs for court reporters, copies, couriers, exhibit preparation, analytical testing, expert witnesses, and similar expenses. The AIPLA estimates are one-sided only, in that they only use costs associated with defending a suit, thereby omitting costs associated with the parties asserting the underlying patents. For the total savings estimates that we present, however, we assume that the plaintiff costs match those of the defense. Supporting this assumption, the 2015 AIPLA economic survey

indicated that a majority of survey respondents reported that assertion costs are the same as defense costs.[86]

We present our estimated litigation-cost savings in Table 3. Column 1 acknowledges that, at the present, 430,056 utility patent applications are disposed of each year. The average number of times each application will culminate in a patent that is the subject of litigation at federal district court is 0.0129, in which event we predict that of these 430,056 disposals we will expect to observe roughly 5,561 patent-lawsuit pairs, as reported in Column 2. We treat the outcome of interest as a patent-lawsuit pair, acknowledging that individual lawsuits may cover a group of patents. Next, we predict the reduction in the number of these patent-lawsuit pairs that is implied by the regression estimate from Table 2—i.e., a 44% reduction in the number of times a patent will be the subject of a lawsuit due to a doubling of examination time. Doing so, we anticipate observing 2,436 fewer patent-lawsuit pairs per year, as reported in Column 3. We then translate this amount into litigation savings per year.

In the Online Appendix, we derive an estimate for the expected litigation costs associated with an average patent-lawsuit pair. For such purposes, we draw on data from several sources: (1) the annual Report of the Economic Survey from the AIPLA, which provides annual breakdowns of average litigation costs associated with cases, set forth by stages of litigation reached and by amounts at stake in the lawsuit; (2) a recent working paper by Christopher Cotropia and colleagues, *A Granular Analysis of Civil Litigation*,[87] which, among things, assesses the distribution of case terminations across different stages of trial for sixteen thousand patent infringement lawsuits; and (3) data on patent infringement lawsuits from the Lex Machina database, including information on the resulting damages for those suits with damages awards. As explained in far greater depth in the Online Appendix, with these data, we derive the probability distribution associated with different types of lawsuits—consisting of different combinations of amounts at stake and the litigation stage at time of case termination—along with the costs associated with litigating the relevant lawsuit type.[88] With this distribution, we estimate that the total litigation costs associated with an average lawsuit is $539,949.[89] To determine the average cost per patent-lawsuit pair, we divide this estimate by the

86. AM. INTELLECTUAL PROP. LAW ASS'N, 2015 REPORT OF THE ECONOMIC SURVEY 41 (2015).

87. Christopher A. Cotropia, Jay P. Kesan, Kyle Rozema & David L. Schartz, A Granular Analysis of Civil Litigation (Aug. 2018) (unpublished manuscript) (on file with authors).

88. Online Appendix, *supra* note 9, at 9–12.

89. *Id.* at 11.

average number of patents that are included in each case filing over our sample period (2.3 years) to arrive at an estimated cost per patent-lawsuit pair ($234,761).[90] Considering the number of patent-lawsuit pairs that we predict will be eliminated by doubling examination hours, we predict that doubling examination time will be associated with a savings in future litigation expenses per year of roughly $572 million.[91]

Because the litigation savings will occur in the future but the costs associated with doubling patent examiner time allocations and the patent prosecution legal savings occur immediately, the final step of our calculation will adjust the litigation savings to account for this difference in timing.[92] Calculating the present value of future litigation savings requires two additional pieces of information: (1) how far into the future the litigation savings will materialize and (2) the appropriate discount rate. We obtain the first piece of information by calculating the age distribution of patents litigated. We find that on average patents experience their first litigation filing 3.1 years following the date of allowance. Of course, many of the patents over our sample period are litigated more than once. When considering the full distribution of litigated patents and the time to litigation for the second, third, etc. times that a patent is litigated, we find that the average patent litigation begins roughly 3.4 years following the date of allowance. We next acknowledge that not all litigation expenses are incurred at the time a lawsuit is filed. The bulk of litigation expenses accounted for in our estimate of the costs per patent-lawsuit pair are attributed to the expenses incurred up to the end of discovery or claim construction. According to the working paper by Cotropia and colleagues, this milestone occurs, on average, twenty-two months after the lawsuit is filed.[93] Compiling this information, we thus envision that the expenses associated with the average patent-lawsuit pair will occur roughly 5.2 years following the date of patent issuance.

Next, we consider the appropriate discount rate. There is a growing literature considering the choice of discount rates in regulatory

90. *Id.* at 11.

91. We calculate this number by multiplying the estimated cost per patent-lawsuit pair of $234,761 by the number of 2,436 forgone patent-lawsuit pairs per year.

92. Technically, the increase in examination costs (and estimated reduction in prosecution expenses) are not all incurred simultaneously but are instead incurred over a period of time. To simplify matters, however, we elect not to discount these examination-related figures. Rather, we elect to start the clock, for discounting purposes, at the moment of time in which the relevant patents are issued. The key point for the purposes of this discussion is simply that the litigation savings will be incurred at a later period of time.

93. Cotropia et al., *supra* note 87 (manuscript at 18).

settings.[94] If the Patent Office increases examiner time allocations, as discussed in Section III.A below, the Agency would likely cover these additional personnel expenses by increasing its fees. An increase in fees of this magnitude would be an "economically significant" regulation—that is, the increase would be considered a rule that creates an economic impact of at least $100 million.[95] This would require the Patent Office to perform a cost-benefit analysis similar to the one outlined in this Article.[96] Therefore, we elect to utilize the discount rates suggested by the Office of Management and Budget of 3% and 7%, as the Patent Office would be required to do as well.[97] Using a 3% discount rate and considering the average time to litigation, we find that the $572 million in annual litigation savings stated above is presently valued at $491 million. If we were to use a 7% discount rate, this figure would fall to $402 million.

Finally, how does the existence of PTAB, which came into effect in September 2012, complicate the analysis that relies on application and federal court litigation data from 2001 through 2017? To the extent that PTAB creates a substitute for the litigation of a patent's validity in federal courts, one may be concerned that PTAB would dampen the relationship between examination time and the degree of litigation savings. As such, one may be concerned that we are overstating the degree of litigation savings as an ongoing matter by using litigation data from the entire post-2001 time period—over ten years of which the PTAB did not exist.[98]

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94. *See* William J. Baumol, *On the Social Rate of Discount*, 58 AM. ECON. REV. 788 (1968); Daniel A. Farber & Paul A. Hemmersbaugh, *The Shadow of the Future: Discount Rates, Later Generations, and the Environment*, 46 VAND. L. REV. 267 (1993); Frank Partnoy, *Corporations and Human Life*, 40 SEATTLE U. L. REV. 399 (2017); Cass R. Sunstein & Arden Rowell, *On Discounting Regulatory Benefits: Risk, Money, and Intergenerational Equity*, 74 U. CHI. L. REV. 171 (2007).

95. Exec. Order No. 12,866, § 3(f), 58 Fed. Reg. 51,735, 51,738 (Sept. 30, 1993).

96. In 1981, President Reagan mandated by Executive Order that administrative agencies perform cost-benefit analysis for all economically significant regulations. Exec. Order No. 12,291, § 2(d), 48 Fed. Reg. 13,193, 13,194 (Feb. 19, 1982). This mandate has remained in force across every subsequent administration. *See* Exec. Order No. 12,866, § 1(a), 58 Fed. Reg. at 51,735 (Clinton); Exec. Order No. 13,563, § 1, 76 Fed. Reg. 3,821, 3,821 (Jan. 18, 2011) (Obama).

97. *See, e.g.*, U.S. PATENT & TRADEMARK OFFICE, 1991 ANNUAL REPORT 30–31 (1991) (discussing the requirement to use a discount rate of three percent and seven percent).

98. At the outset of this discussion, we justify our choice of using the longer time period given the complexities of our empirical design. We are trying to trace out how litigation likelihoods (and patent grant rates) evolve as GS-levels of examiners change while also separating GS-level effects from general overall time trends in litigation rates, changes in experience levels of examiners, etc. This separation exercise requires notable temporal breadth in the data, limiting our ability to do so while only focusing on the most recent time period. It is also critical to use a long time period in light of the gap in years that often spans between patents issuing and being the subject of subsequent litigation.

TABLE 3: SIMULATED REDUCTION IN LITIGATION EXPENSES ASSOCIATED WITH DOUBLING AMOUNT OF TIME ALLOCATED TO EXAMINERS

(1)	(2)	(3)	(4)
Number of Annual Reviews Completed by Examiners	**Expected Number of Federal Case-Application Pairs Arising from Annual Reviews**	**Estimated Decrease in Number of Patent Case-Application Pairs from Doubling Examination Hours**	**Estimated Decrease in Litigation Costs from Doubling Examination Hours**
430,056	5,561	2,436	$571,876,758.10

The number of applications disposed of by the Patent Office that is indicated in Column 1 is based on the number of dispositions of regular utility patent applications from the 2016 PAIR data. Expected litigation outcomes for these dispositions is based on the mean number of times an application is litigated in court based on the PAIR data merged with litigation data from the Lex Machina database. The estimated decrease in litigation events reported in Column 3 is derived from the results from Table 4. The litigation cost data that form the basis for the estimates in Column 4 are from the (AIPLA surveys, as discussed in further detail in the Online Appendix.

To address this concern, we begin by examining whether PTAB is in fact a substitute for federal court litigation. At the onset, we note that preliminary evidence put forth by others tends to refute this substitution hypothesis. As noted above, the overwhelming number of patents that are subject to a petition before PTAB are also the subject of an action before a federal district court.[99] Moreover, the vast majority of patents whose validity is challenged in any capacity are still only litigated in federal district court.[100] In our own data, litigation rates appear to be comparable before and after the America Invents Act ("AIA"), which created PTAB, further cutting against the substitution hypothesis. More specifically, we find that the number of times a patent application ultimately becomes the subject of a federal lawsuit is slightly larger in the post-AIA period relative to the pre-AIA period.[101]

99. *See* Vishnubhakat et al., *supra* note 73, at 81.

100. *Id.* at 69.

101. To determine this, we compare the mean number of times that a patent application becomes the subject of a federal patent lawsuit filed during the four years following the AIA's effective date—i.e., 2013 to 2016—with the mean number of times that a patent application becomes the subject of a federal patent lawsuit filed during the four years prior to the AIA's passage—i.e., 2008 to 2011. This comparison is of course difficult given the time lag between when patents issue and when they are litigated, which means we do not necessarily want to limit ourselves to patent applications that were filed during those two windows. However, we also want to make sure to keep consistent across the comparison groups the length of time we observe applications so that we equalize exposure and lawsuit-filing opportunity periods across our two comparison groups. Accordingly, when determining the 2013 to 2016 litigation likelihood, we do so

To further address the concern that we overestimate litigation savings in light of PTAB's creation in 2012, we assess whether our estimated relationship between time allocations and reduced litigation events is affected by the inclusion or exclusion of post-AIA data. We find that the removal of the post-AIA years from our sample has no effect on our estimates from Table 2 that a doubling of examination time allocations results in a 44% reduction in the number of times an application is ultimately the subject of a federal patent lawsuit.[102]

Taken in tandem, these two findings—that is, more litigation events after the AIA and hours-litigation-rate estimates that are unaffected by the AIA—suggest that our federal court litigation savings analysis is unchanged by the introduction of PTAB.[103] In fact, the

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while focusing on those applications disposed of by the Patent Office between 2009 and 2012—i.e., the four years leading up to the effective date of the AIA. And when determining the 2008 to 2011 litigation likelihood, we do so while focusing on those applications disposed of by the Patent Office between 2004 and 2007—i.e., the four years leading up to the relevant litigation observation period.

More specifically, we find that the number of times a patent application ultimately becomes the subject of a federal lawsuit is larger in the post-AIA period (0.009) relative to the pre-AIA period (0.007). We do not mean to create any inference that the fundamental degree of litigiousness increased after the AIA based on this fact. Any such inference is not necessary for the point of this Article's cost-benefit exercise. In fact, part of this increase in expected litigation outcomes may be attributable to the heightening of the joinder standard set forth in Section 299 of the AIA, which made it more difficult for plaintiffs to join multiple defendants in a single case. *See* 35 U.S.C.A. § 299 (West 2019). We do not dispute the possibility that this joinder provision may have contributed to a higher than expected number of patent-lawsuit pairs arising from insufficient time allocations, but this does not undermine our analysis. On the contrary, it perhaps reinforces it. The arguable inefficiencies in this joinder reform may only heighten what is at stake in terms of the litigation costs stemming from examination time deficiencies and thus the savings that may arise in litigation expenses from giving examiners more time.

102. By "pre-AIA years," we mean that we focus only on applications that were disposed of and lawsuits that were filed prior to the AIA being enacted.

103. Out of those fewer patent-lawsuit pairs that we predict will result each year as a result of doubling time allocations, it is likely that a small subset of these pairs will exist contemporaneously with ongoing PTAB challenges. We acknowledge that in this case the litigation costs associated with these pairs may be lower than the average costs that we calculate for a patent-lawsuit pair in the Online Appendix to the extent that the federal litigation itself may be stayed during the course of the PTAB proceedings. While this may mean that we are overstating our litigation savings, it is unlikely that we would be doing so by an extensive amount. To begin, only a small number of cases would be of this overlapping nature. As stated elsewhere in this Article, the expected number of times an application will be asserted in litigation is 0.0129, whereas the expected number of times an application will be the subject of a PTAB institution is 0.00088. In other words, litigation is over fourteen times as likely as a PTAB institution. If we conservatively assume that all PTAB institutions are also the subject of litigation, this would still suggest that only 7% of the patent-lawsuit pairs are also the subject of a PTAB institution (0.00088 / 0.0129). Even if we further conservatively assume that the litigation costs associated with these 7% of cases are only half of the amount reported by the AIPLA for litigation expenses up to the point of case management, this would mean that our litigation savings would fall by only $31 million per year, down to a total of $540 million per year in savings.

There is even good reason to believe that the litigation savings would not fall down to $540 million in light of stayed litigation. To arrive at the litigation-savings estimates reported in Table

introduction of PTAB only reinforces this Article's conclusion that the savings from increased examination time justify the costs. After all, if increased examination time reduces the issuance of invalid patents, this may also lead to savings in PTAB-related legal expenses. In the following Section, we attempt to estimate such additional savings.

4. Empirical Investigation of the Link Between Examination Time Allocations and PTAB Savings

To investigate the amount of PTAB savings that may ensue from increasing examination time, we utilize the same methodological approach employed in the preceding Section but switch outcome variables. Instead of exploring how doubling examination time leads to a change in the number of times a patent application ultimately winds up in litigation, we explore how it leads to a change in the number of times an application ultimately winds up the subject of a PTAB proceeding.[104]

Column 2 of Table 2 estimates the same specification estimated in Column 1 (which pertained to litigation frequencies) but replaces the

3, we utilize patent-application data from the full post-2001 period. We do so as this enables a more reliable estimate of the amount of patent-lawsuit pairs that may be reduced by doubling patent examination hours given the cumbersome empirical task associated with separating the effects of GS-level changes from experience effects, annual changes in grant rates and litigation outcomes, and other factors. Nonetheless, if we really want to understand what the litigation savings are in the post-PTAB/post-AIA era in light of this concern over litigation stays in that small amount of cases with an overlap, we would arguably want to focus solely on post-AIA data in producing the total litigation savings estimate. It would seem inappropriate to fully discount the average annual savings we estimate using data from the post-2001 era by 7% when PTAB-related stays only became relevant at the end of that period. As discussed above, when we reestimate the relationship between GS-level changes and litigation likelihoods focusing on post-AIA data, our point estimates do not change. If anything, the underlying rate of litigation itself increases notably following the AIA—by as much as 25% relative to the mean—in which event we might predict a greater reduction in the number of patent-lawsuit pairs by focusing only on this recent data. Relatedly, the numbers of patents per case is lower in recent years, in which event the per-case amounts reported by the AIPLA (and that are key inputs to our calculations in the Online Appendix) would not need to be scaled down by as much as we are doing to produce Table 3. All told, if we were to attempt to predict the amount of annual litigation savings from doubling examination hours just considering post-AIA years, the savings would likely exceed that reported in Table 3 by a percentage amount exceeding 7%. Accordingly, we see no reason to believe that the concern over stayed litigation arising in the post-AIA period (for overlap cases) will change the ultimate conclusion that we reach in this Article—i.e., that the savings associated with doubling examination hours will likely exceed the costs.

104. This exercise is likely to produce slightly noisier estimates for two reasons. First, as already discussed, PTAB is used less frequently than litigation. Second, even though patent applications filed throughout the sample period have implicated PTAB challenges, such challenges were only filed subsequent to September 2012, when PTAB became effective, unlike litigation, which was naturally an option all throughout the sample period. This only further reduces the mean incidence of PTAB over our sample of applications. With lower baseline rates, it presents a greater statistical challenge in estimating the impacts of GS-level changes on PTAB challenge frequencies.

outcome measure of interest, instead using the number of times the relevant patent application became the subject of a PTAB challenge up to March 2016, when our PTAB data ends. As with litigation outcomes, we continue to find that the number of times an application results in a patent that is the subject of a PTAB challenge rises as the amount of examination time associated with that application falls, as identified by changes in the GS-levels of the associated examiners.[105] As before, the GS-level 14 coefficient—which is to be interpreted with reference to a GS-level 7 effect—provides us with a way to explore the effect of doubling examination time on PTAB events. The results imply that the normalized incidence rate of PTAB activity at GS-level 14 is roughly 3.55 relative to the baseline incidence rate of 1.0 for GS-level 7. Moving examiners from GS-level 14 to GS-level 7 time allocations—i.e., doubling their time—would thus lead to a roughly 72% (2.55 / 3.55) reduction in the frequency of PTAB challenges.

In Table 4, we consider what this reduction implies in terms of PTAB expense savings. Table 4 follows the same structure of Table 3 in the case of litigation savings. To understand the computation of the savings estimates in Column 4, first note that 430,056 utility patent applications are disposed of each year, as reported in Column 1. The average number of times these applications will culminate in a patent that becomes the subject of a PTAB challenge is 0.00088, in which event we predict that of those 430,056 disposals roughly 378 will be the subject of an instituted PTAB petition.[106] By doubling examination time, we predict that this number will fall by 72%, or by 272 instituted PTAB challenges. To determine the total savings in PTAB-related litigation expenses stemming from this reduction in PTAB challenges, we multiply this amount by the average litigation costs associated with PTAB proceedings, which we likewise derive from the Annual Report of the Economic Survey of the AIPLA, as discussed in greater detail in the Online Appendix.[107] All told, our analysis implies a considerable degree of savings—over $123 million.

Similar to the litigation savings presented in Section II.A.3, we must account for the difference in time associated with the PTAB-

105. This pattern is not perfectly monotonic, however. In general, PTAB frequencies rise with each iterative GS-level promotion, except that there is an especially high spike in PTAB frequencies for GS-level 11 applications. Again, however, some noise in this relationship is to be expected given the notable rarity in ultimate PTAB challenges over our entire sample of applications.

106. This estimate is nearly unchanged when we instead consider the mean number of PTAB challenges over the full sample period, including applications disposed of all the way up until the last period for which we have data on PTAB challenges (March 2016).

107. Online Appendix, *supra* note 9, at 9–12.

related litigation savings. Unfortunately, it is not altogether straightforward how to go about determining the average time gap between patent issuance and the onset of PTAB proceedings, at least as a matter moving forward. The key difficulty in doing so is that PTAB proceedings did not begin until late 2012, in which event the gap between patent issuance and PTAB proceedings using data from our full sample period would provide a misleading sense of the true gap. Moreover, the difficulty with relying on patents issued in recent years is that the data is naturally truncated at the right end, likewise leaving an imperfect sense of the true gap between patent issuance and PTAB proceedings. To address these concerns, we simply focus on those patents issued in 2012. With this restriction, we find that the average time between patent issuance and the onset of PTAB proceedings is 2.1 years. We assume that the bulk of the PTAB expenses associated with each PTAB challenge are incurred one year after the filing of a PTAB challenge. As such, we discount the $123 million in savings by 3.1 years, which, using a 3% discount rate, suggests an annual savings of $112 million ($100 million if we were to use a 7% discount rate).

TABLE 4: SIMULATED REDUCTION IN PTAB EXPENSES ASSOCIATED WITH DOUBLING AMOUNT OF TIME ALLOCATED TO EXAMINERS

(1)	(2)	(3)	(4)
Number of Annual Reviews Completed by Examiners	**Expected Number of PTAB Challenges Arising from Annual Reviews**	**Estimated Decrease in Number of PTAB Challenges from Doubling Examination Hours**	**Estimated Decrease in PTAB Challenge Costs from Doubling Examination Hours**
430,056	378	272	$123,080,000

The structure of this Table parallels that of Table 3. Data on PTAB challenge costs are likewise from the 2015 Annual Survey of the AIPLA.

Finally, we emphasize that the estimates of PTAB litigation savings focus only on the costs of defending and bringing a PTAB challenge. They do not include the costs to the Patent Office itself in employing PTAB judges and associated staff. Conceivably, with a substantial reduction in PTAB challenges stemming from the hypothesized doubling of examination time, the Patent Office could save further personnel resources.

B. Possible Prosecution Savings to Patent Applicants

The second possible savings associated with increasing examiner time allocations is a decrease in prosecution expenses to patent applicants.[108] In contrast to the litigation savings above, it is theoretically ambiguous whether giving patent examiners more time will lead to a decrease in costs incurred by the prosecuting attorneys (and hence patent applicants).

Increasing the time allocations of patent examiners could result in examiners making clearer and better thought out rejections, which in turn could enable the prosecuting attorney to either more quickly obtain a patent grant or determine that the application should be abandoned because it fails to meet the patentability standards. Because the patent examination process involves a back and forth between the patent examiner and the prosecuting attorney, it is possible that improved examination could decrease the number of rounds of review at the Patent Office, resulting in a financial savings to the patent applicant. Our prior empirical work lends some support to the contention that if a patent examiner makes an initial low-quality rejection, which our evidence suggests examiners often do under time pressures near deadlines, this low-quality rejection will increase the time an application is under review at the Patent Office and result in additional rounds of review.[109] In short, when examiners make quick, low-quality rejections in early rounds of review in order to meet deadlines—rejections that are nonfinal in nature—they will need to make up for these initial low-quality rejections in later rounds. The implication is that time pressures may cause examiners to waste rounds of review.

On the other hand, increasing the time allocations of patent examiners is likely to result in a more rigorous examination in which better, more comprehensive rejections are made. It is possible that as the quality of examination increases, it will require prosecuting attorneys to spend more time responding to these rejections, which may generate added social costs not potential savings. This may be especially true if patent examiners begin making more complicated or

108. This Section concludes that doubling examiner time allocations results in potential savings rather than increased patent prosecution expenses. Nevertheless, we elect to discuss the effect of increasing examiner time allocations on patent prosecution expenses in Section II.B because, as discussed above, the theoretical relationship is unclear and because Lemley believed they were a cost. Lemley, *supra* note 3, at 1497.

109. Michael D. Frakes & Melissa F. Wasserman, *Procrastination in the Workplace: Evidence from the U.S. Patent Office* 6 (Nat'l Bureau of Econ. Research, Working Paper No. 24159, 2018). In the Online Appendix, we spell out in greater detail the essence behind the prediction that greater examination time may lead to fewer rounds of review. Online Appendix, *supra* note 9.

complex rejections, such as obviousness rejections that include a large number of prior art references.[110]

As such, there may be some reason to think that prosecution costs will go down and some reason to think they will go up by giving examiners more time. Accordingly, we attempt to provide empirical insight into this question. Our empirical inquiry will consist of two parts, each bearing on the points raised in the above conceptual discussion: (1) we will explore whether more examination time can eliminate some degree of the unproductive back and forth between examiners and prosecutors and diminish the number of rounds of review (also known as "office actions") and (2) we will explore whether more examination time leads to more complex rejections in a given round of review and hence increased per-office-action expenses.

We test the first question directly. The methodology underlying our approach is essentially identical to that employed in Section II.A, which discusses litigation savings. In short, that design follows examiners throughout promotions that reduce the amount of time they have to review applications and observes the impacts of such time-reducing promotions on the number of rounds of reviews associated with the application (all while controlling for other factors that may correlate with these promotions and with the various application outcomes—e.g., years of examiner experience). In the Online Appendix, we further discuss the challenges associated with this exercise and some robustness checks that we undertake in the face of these challenges.[111] All told, this empirical exercise provides no evidence to support any claim that greater examination time leads to a greater number of rounds of review. In fact, the evidence is consistent with the above prediction that greater examination time may lead to fewer wasted rounds of review.

In our preferred specification, we find that doubling examination time is associated with 0.56 fewer rounds of review per application,

110. We note, however, that one may not necessarily expect prosecution costs to increase substantially following examiner time increases in that the vast majority of costs of obtaining a patent are associated with drafting of the initial application, which are fixed at the time of filing. AIPLA 2017 REPORT, *supra* note 68, at 30–31 (preparing and filing an original application of minimal complexity has a median legal charge of $7,000 whereas preparing and filing a response to an office action has a median legal charge of $2,000; preparing and filing an original application in the field of biotechnology and chemistry has a median legal charge of $10,000 whereas preparing and filing a response to an office action has a median legal charge of $3,200; preparing and filing an original application in the field of electrical and computer technology has a median legal charge of $10,000 whereas preparing and filing a response to an office action has a median legal charge of $3,000; preparing and filing an original application in the mechanical field has a median legal charge of $8,500 whereas preparing and filing a response to an office action has a median legal charge of $2,800).

111. Online Appendix, *supra* note 9, at 13–18.

implying that greater examination time may cut prosecution expenses to the extent that greater time leads to less back and forth between examiners and applicants. The approximate savings implied by these estimates are considerable. To derive these estimated savings, the analysis assumes that all rounds of review are of modest complexity, parallel to that of mechanical fields, an assumption (per Table 5) that suggests a cost of $2,500 per round. In light of (1) this cost, (2) the estimated reduction of 0.56 rounds, and (3) the fact that the Patent Office disposes of roughly 430,000 applications per year, these elements suggest that the patent system may experience upward of $602 million savings per year in reduced prosecution expenses in connection with doubling examination time. We acknowledge that this aggregate estimate assumes that costs per round of review remain flat in connection with changes in time allocations.

It is of course important to look beyond the decreased rounds of review and examine whether an expansion in examination time may lead to increased costs per round of review. To confront this second question, we conduct a simple empirical exercise in which we attempt to provide a rough estimate of increased prosecution expenses per office action stemming from an increase in time allocations. Should the complexity of rejections that prosecutors must respond to increase, it is possible that prosecutors would increase their per-office-action fees in response. To test this, we exploit the fact that the Patent Office increased the time allocations to all patent examiners by two hours in 2010—representing a roughly 12% increase in time.[112] By looking at the reported fees charged by patent attorneys for prosecuting patent applications immediately before 2010 and then shortly thereafter, we can attempt to identify whether an increase in time allocations of this magnitude resulted in increased prosecuting fees. The AIPLA reports the median charges for patent services every two years based on a survey of its members,[113] Table 5 reproduces the median attorney's fees associated with responding to a patent examiner's rejection in 2008, 2010, and 2012 for a variety of technologies and by complexity of application.

112. Frakes & Wasserman, *supra* note 12, at online app. at 2.

113. AIPLA 2017 REPORT, *supra* note 68, at 1.

TABLE 5: MEDIAN CHARGES FOR SERVICES: U.S. UTILITY PATENTS[114]

APPLICATION AMENDMENT/ARGUMENT	**2008**	**2010**	**2012**
Minimal complexity[115]	$1,850	$1,800	$1,800
Relatively complex—biotechnology/chemical	$3,200	$3,000	$3,000
Relatively complex—electrical/computer	$3,000	$3,000	$3,000
Relatively complex—mechanical	$2,500	$2,500	$2,500

Notably, the attorney's fees associated with responding to a patent examiner's rejection stayed flat or decreased from 2008 to 2012. Thus, it does not appear that the Patent Office's 2010 two-hour increase in time allocations increased the legal charges associated with prosecuting a given round of review. This natural experiment is, of course, not perfect. There are certainly other factors that may impact the legal charges associated with prosecuting a patent, potentially confounding this analysis.[116] For instance, changes in the legal market (i.e., law firm mergers) or economic conditions could artificially depress legal charges associated with prosecuting patents during this time period, which may otherwise mask increases in prosecution costs stemming from increased examination time. We note, however, that median litigation costs for patent infringement were also constant during this time period.[117] Thus, if one thought that changes in the legal market or economic conditions were artificially depressing legal charges associated with prosecuting patents during our time of inquiry, then one might expect to see corresponding changes in litigation costs for patent infringement. Ultimately, this exercise tends to support that an

114. *See id.* at 30–31.

115. A "minimal complexity" patent application is defined as an application that has a ten-page specification and ten claims. *Id.* at 5.

116. It is also possible that attorney's fees do not scale linearly with the time allocations of patent examiners. That is, a modest increase of two hours in time allocations may not result in any additional legal charges, but, for instance, doubling the time an examiner spends reviewing a patent application could have an impact on attorney's fees. Even if this is the case, it is important to note that the vast majority of the legal costs associated with prosecuting a patent application are associated with the initial drafting of the patent application. *Id.* at 30.

117. *Id.* at 41.

increase in examiner time allocations does not lead to notable increases in prosecution expenses.[118]

Given the limitations of the natural experiment for testing the effect of time allocations on costs per round of review[119] and given the methodological concerns raised in the Online Appendix surrounding the estimated 0.56 effect,[120] we elect to take a conservative approach and heavily discount this $602 million savings estimate. In particular, for the purposes of the cost-benefit calculation at the heart of this Article, we conservatively assume that these savings are half as large as this estimate. As such, this Article proceeds with an estimated savings in prosecution costs of $301 million per year.

C. Other Savings from Investing More in Ex Ante Patent Examination

Section II.A provides estimates of litigation savings—both in federal courts and in PTAB challenges—that would result from the Patent Office issuing fewer invalid patents in response to doubling patent examiner time allocations and Section II.B provides estimates of prosecution savings associated with doubling examiner time allocations. Of course, invalid patents impose costs on society beyond wasteful litigation expenses. Most fundamentally, improvidently granted patents can result in supracompetitive pricing due to the exclusionary power provided by patent protection. This in turn may price individuals out of the relevant market, including individuals that would value the product more than the cost of production. While society may accept such consequences for a properly issued patent in return for the notion that such profits were necessary to induce innovation in the first place, an invalid patent imposes these costs on society without providing the commensurate benefits.[121] For instance, the promise of a patent is not needed to induce the development of technology that is not new. As such, under proper application of the patentability standards, patent applications on such technologies should be denied patent protection.

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118. We note that our analysis assumes that practicing attorneys would be able to monetize their greater efforts by increasing the legal charges associated with prosecuting patent applications. While fixed-fee arrangements may initially dampen efforts to do so, if greater examiner time allocations do lead to greater levels of time and effort by applicant's attorneys, increases in fixed-fee levels would be possible over time as new client and/or fee relationships are established.

119. *See supra* notes 112–113 and accompanying text.

120. Online Appendix, *supra* note 9, at 5–9.

121. Mark A. Lemley & Bhaven Sampat, *Examiner Characteristics and Patent Office Outcomes*, 94 REV. ECON. & STAT. 817, 817 (2012).

Of course, the costs of invalid patents extend beyond those simply related to monopoly-driven deadweight losses. Invalid patents can also be utilized by non-practicing entities or patent trolls to opportunistically extract licensing fees from innovators[122] and inhibit the ability of startups to obtain venture capital.[123] Erroneously issued patents can also impede competitors from entering markets[124] and stunt follow-on research.[125] These harms, however, are very difficult to quantify.

Take, for example, follow-on innovation, for which two recent, notable papers have provided insight on the effect of patents on cumulative innovative efforts.[126] Because a given discovery may be utilized as an input in later follow-on discoveries, nearly all innovation is cumulative in nature. If a patent is issued to an invention that fails to meet the patentability standards, the invalid patent could act to curtail follow-on efforts by blocking other innovators from using the invention associated with the invalid patent as an input to subsequent innovation. In the first of these two recent papers, Alberto Galasso and Mark Schankerman study the cumulative impacts patents may have on innovation by exploring the consequences following the invalidation of a patent by a court.[127] Under this approach, they find that patents impede follow-on innovation but only in very specific scenarios. For instance, they find that patent invalidations have a significant impact on cumulative innovation only in the fields of computers and communications, electronics, and medical instruments (including biotechnology)—they find no effect for drugs, chemicals, or mechanical technologies.[128] Additionally, they show that the effects of patent rights

122. James Bessen, *The Patent Troll Crisis is Really a Software Patent Crisis*, WASH. POST: THE SWITCH (Sept. 3, 2013), https://www.washingtonpost.com/news/the-switch/wp/2013/09/03/the-patent-troll-crisis-is-really-a-software-patent-crisis [https://perma.cc/3RVS-JRJ3] (noting that patents are generally overly broad and vaguely worded).

123. *See* FED. TRADE COMM'N, *supra* note 2, at 8 ("The threat of being sued for infringement by an incumbent [patent holder]—even on a meritless claim—may 'scare . . . away' venture capital financing." (quoting public comment of Joshua Lerner, Professor, Harvard Business School)).

124. *See id.* at 3 (noting that allowing patents on obvious inventions can thwart competition); Leslie, *supra* note 61, at 119–25 ("[A] new entrant concerned about infringing an existing patent must pay to investigate the patent's scope and validity . . . [which poses] a barrier to entry . . . .").

125. Heller & Eisenberg, *supra* note 62, at 698; Scotchmer, *supra* note 62, at 32 (noting that overly broad patent protection "can lead to deficient incentives to develop second generation products").

126. *See* Alberto Galasso & Mark Schankerman, *Patents and Cumulative Innovation: Casual Evidence from the Courts*, 130 Q.J. ECON. 317 (2015); Bhaven Sampat & Heidi L. Williams, *How Do Patents Affect Follow-on Innovation: Evidence from the Human Genome* (Nat'l Bureau of Econ. Research, Working Paper No. 21666, 2015), https://www.nber.org/papers/w21666.pdf [https://perma.cc/V5BQ-SQJQ].

127. Galasso & Schankerman, *supra* note 126.

128. *Id.* at 321–22.

on later innovation depend critically on the characteristics of the transacting parties.[129] Their entire findings are driven by one specific scenario: the number of small innovators increases when patents by large firms are invalidated.[130] While Galasso and Schankerman provide compelling empirical evidence on the heterogeneous nature of patent invalidation on cumulative innovation, they are also careful to emphasize that their paper involves the judicial removal of an existing patent right.[131] As they note, there are some conceptual differences between this scenario and when patents are never granted in the first place, which could limit the generalizability of their findings to the issue in this Article—quantifying the potential gains associated with the Patent Office issuing fewer invalid patents.[132]

In the second of these recent papers, Bhaven Sampat and Heidi Williams examine the extent to which patents on human genes affect follow-on scientific research and product development.[133] Sampat and Williams estimate that patents on human genes have largely a negligible effect on follow-on innovation, echoing the corresponding findings of Galasso and Schankerman in the relevant technological area.[134] All told, there is some evidence that issuing invalid patents may impede future innovative efforts, but this impediment may be limited to certain technological fields.

As such, it is possible that we could reduce some social harms related to an inhibition of follow-on innovation to the extent that we eliminate invalid patents. Of course, it is critical to keep in mind that both the Patent Office and the courts are tasked with eliminating invalid patents. Hypothetically speaking, if the courts could immediately invalidate all invalid patents issued by the Patent Office, society would perhaps not experience any of the hypothesized harms of invalid patent issuances (other than the costs of litigation itself). In this hypothetical scenario, increasing ex ante review at the Patent Office would thus not result in any savings (beyond reduced litigation costs). In practice, however, the courts do not operate this perfectly. After all, by relying on private enforcement, it is not guaranteed that a litigation system will have the opportunity to assess the validity of all invalid patents that are issued, especially in light of extensive litigation costs. Accordingly, if the courts were to fail to invalidate a patent that is

129. *Id.* at 322.
130. *Id.*
131. *Id.*
132. *Id.*
133. Sampat & Williams, *supra* note 126.
134. *Id.* (manuscript at 29).

substantially impeding follow-on innovation, such harms could indeed be saved to the extent that society invested in stronger ex ante review at the Patent Office to target these bad patents.

Courts are also imperfect in their timing. Courts may, at some point, get around to invalidating a bad patent; however, notable delay may take place before this occurs. In the interim, invalid patents may have the opportunity to inflict these various harms on society—e.g., stalling follow-on innovation. As such, by investing more at the Patent Office and knocking out these invalid patents earlier, we may generate additional savings for society.

Acknowledging the possible mechanisms by which greater ex ante investments could reduce the harms associated with invalid patents, the question then becomes how large are these harms? And how do we quantify them to add to the litigation savings estimates discussed in Section II.A and the prosecution savings estimates discussed in Section II.B? These are substantial questions in need of considerable additional research. While Galasso and Schankerman and Sampat and Williams both studied the impacts of patents on follow-on innovation, neither attempted to quantify the associated welfare impacts. We are also unaware of reliable estimates of the deadweight losses associated with patent-induced monopoly pricing, specifically during the period of time between patent issuance and court invalidation. Given the complexities involved with estimating the corresponding savings associated with these other costs, we have elected to focus our simulation analysis on the calculations over potential savings in litigation, PTAB, and prosecution expenses.

III. COSTS ASSOCIATED WITH INCREASING RESOURCES TO THE PATENT OFFICE

The previous Part calculated the potential savings associated with doubling patent examiner time allocations. Of course, this is only half of the puzzle. In order to determine whether society would be better off devoting more resources to the Patent Office to increase the quality of examination, we must also know the costs associated with doubling the time examiners review patent applications. This Part turns to this task.

Given the hourly costs of employing examiners, increasing the time allocations for reviewing patent applications will result in an increase in the average costs associated with evaluating patent applications. The overall costs incurred by the Patent Office depend on how the Agency responds to its decision to give examiners more time to review individual applications. If the Agency's budget is fixed—i.e., the

Patent Office is not able to increase its operating budget in the face of a doubling of per-application review time—it would necessarily have to reduce the number of applications it processes to ensure its expenses do not exceed its revenue. Given that total, Agency spending would not change in this scenario. The aggregate social costs associated with this approach would largely stem from the harms to patent applicants from having to endure longer waiting periods before the Patent Office begins examining their applications.[135] The costs to the Patent Office itself would largely stem from reputational harms associated with having a growing backlog of patent applications. Alternatively, if the Patent Office could increase its operating budget, then it would maintain its examination capacity while concomitantly providing examiners with additional time to complete more thorough reviews of all applications. Obviously, it would be difficult to do so with its existing workforce given the finite number of hours in a day. This alternative scenario thus necessarily involves the need to hire an additional group of examiners. As a result, the cost to the Patent Office associated with this approach is primarily the personnel expenses stemming from the need to hire and pay additional patent examiners.

If the Agency is committed to expanding examination time allotments, we suggest that it would prefer the latter to the former for several reasons. First, the Agency is under tremendous pressure to continue to decrease its voluminous backlog of patent applications.[136] The Patent Office has cut its backlog of patent applications from a high of over 760,000 in 2007 to just under 570,000 in 2017.[137] Given that the Patent Office has identified that its single biggest challenge is to decrease its patent pendency—that is, the time between filing a patent application and receiving substantive communication regarding its

135. A backlog of patent applications may impose a variety of costs, including "the reduction in value of patent protection for patent applicants; a reduction in the incentive to innovate and undertake research and development; granting of monopoly power to non-patentable applications (through longer pending patent rights); deterring use of the patent system; and the diversion of resources away from productive activities." LONDON ECON., ECONOMIC STUDY ON PATENT BACKLOGS AND A SYSTEM OF MUTUAL RECOGNITION 58 (2010), http://www.ipo.gov.uk/p-backlog-report.pdf [https://perma.cc/ET7P-PHRH]. This report estimates that the cost to the global economy of one extra year of delays at the United States, European, and Japanese patent offices is $7.6 billion. *Id.* at viii.

136. *Top Management Challenges Facing the Department of Commerce in FY 2013: Hearing Before the H. Comm. on Appropriations Subcomm. on Commerce, Justice, Science, and Related Agencies*, 113th Cong. 2 (2013) (statement of Todd Zinser, Inspector Gen. of the U.S. Dep't of Commerce) (noting that addressing patent backlog is one of the top challenges facing the Department of Commerce).

137. U.S. PATENT & TRADEMARK OFFICE, *supra* note 1, at 170 tbl.3.

patentability from the Agency[138]—it seems unlikely that the Agency would be inclined to diminish its patent processing capacity. Second, the Patent Office has the authority, in effect, to increase its budget without having to lobby Congress for additional funds. The Agency is user-fee funded and has the ability to set its fees by rulemaking.[139] The Agency's budget is generally set to the Patent Office's projected fee income for a given year.[140] As a result, by augmenting the fees it charges patent applicants, the Patent Office can increase its budget to accommodate the additional expenses.[141]

Thus, this Article proceeds by assuming the Patent Office would choose to maintain its examination production level in the face of mounting patent review expenses. Given this assumption, the costs associated with increased patent examiner time allocations will primarily be the personnel expenses associated with hiring and paying additional patent examiners. What are the personnel costs associated with doubling the amount of time extended to examiners to review applications? To determine these expenses, we conduct a

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138. U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FOR FISCAL YEAR 2008, at 33 (2008), http://www.uspto.gov/about/stratplan/ar/USPTOFY2008PAR.pdf [https://perma.cc/8U8P-3NXH] (noting the PTO's "biggest challenge is to address the growth of pendency and the backlog of patent applications waiting to be examined"); *Inspector General's Top Management Challenges Facing the USPTO*, U.S. PAT. & TRADEMARK OFF., https://web.archive.org/web/20121010172423/http://www.uspto.gov/about/stratplan/ar/2011/oai_01.html (last visited Apr. 3, 2019) [https://perma.cc/J9F7-GMKW] (noting the management challenge of reducing the patent application backlog); *see also* Jon W. Dudas, *Message from the Under Secretary of Commerce for Intellectual Property and Director of USPTO: Fighting Piracy and Counterfeiting by Protecting Intellectual Property Rights*, U.S. PAT. & TRADEMARK OFF. (Nov. 2, 2005), https://web.archive.org/web/20130425173504/http://www.uspto.gov/about/stratplan/ar/2005/02_message_director.jsp [https://perma.cc/DPY4-XWNU] (noting that the "volume and complexity of patent applications continues to outpace current capacity to examine them" and the PTO has "backlog of historic proportions").

139. *See* 35 U.S.C. § 41 (2012); Final Rule Setting and Adjusting Patent Fees, 78 Fed. Reg. 4,212, 4,224 tbl.4 (Jan. 18, 2013) (to be codified at 37 C.F.R. §§ 1, 41, 42). Since 1991, the Agency has funded its operations almost entirely through user fees. *See* Omnibus Budget Reconciliation Act of 1990, Pub. L. No. 101-508, § 10101, 104 Stat. 1388. The Patent Office's budget in 1991 was over $370 million, of which $3 million were from general revenue funds. U.S. PATENT & TRADEMARK OFFICE, *supra* note 97, at 1–2.

Of course, alternatively, the Patent Office could lobby Congress to increase its budget through funding the Agency in part through tax revenues. However, mounting concern regarding deficit containment as well as Congress's past track record of utilizing the Patent Office's fees to fund other governmental activities (even when the Agency's financial sustainability was in question) suggests this is unlikely to be successful.

140. Michael D. Frakes & Melissa F. Wasserman, *Does Agency Funding Affect Decisionmaking?: An Empirical Assessment of the PTO's Granting Patterns*, 66 VAND. L. REV. 67, 76–77 (2013).

141. *Id*. at 76–80 (describing the Patent Office's budgetary process). Moreover, the limitation that the Agency can only set its fees so that, in the aggregate, its fees cover its expenses would in no way limit the Agency's ability to modify its fees to cover the additional examination expenses. *See* 35 U.S.C. § 41 (codifying patent fees).

straightforward accounting exercise in Table 6. We begin by considering the 430,056 regular utility applications[142] disposed of by the Patent Office in 2016, breaking down those applications into the GS-levels of the associated examiners. In light of the average number of hours allocated to the various GS-levels, we then determine for each GS-level the number of additional hours the Agency would need to fund in order to double the amount of time extended to each application. We then multiply these hours by the costs per hour to employ patent examiners at the various GS-levels. Where such costs account for the relevant salary at that GS-level in addition to a range of related costs—such as fringe benefits, office expenses, and equipment—we make various conservative assumptions to account for these supplementary expenses.[143] Overall, using 2016 figures, this exercise suggests that

142. By "regular," we mean excluding provisional applications and applications filed under the Patent Cooperation Treaty.

143. To determine the hourly costs, we start by considering hourly salaries across GS-levels (beginning with GS-level 5) from 2016. *General Schedule (GS) Payscale Table for 2016*, FEDERALPAY.ORG, https://www.federalpay.org/gs/2016 (last visited Jan. 6, 2019) [https://perma.cc/X6ES-QCV7]. Of course, the full cost of an employee to an organization exceeds their base salary. Account must be made for fringe benefits, employer taxes and insurance, and allotments for office space, rent, equipment, replacement and turnover costs, managerial support, and other such costs. The Patent Office does not report these costs for a marginal employee hour. Nonetheless, we researched accounting practices for determining the indirect costs of employee time for organizations that we thought would be comparable in nature (in terms of employee tasks) to the Patent Office—i.e., organizations contracting with the federal government where such organizations need to account for the costs of employee effort to be able to develop governmental bids. Deltek surveys government contracting agencies for these purposes and reports average indirect costs in a recent study. *See* DELTEK CLARITY, GOVERNMENT CONTRACTING INDUSTRY STUDY (2018), http://more.deltek.com/gc-clarity-2018?sourceid=19&utm_source=blogs&utm_medium=website&utm_campaign=GovConBlog&cmp=website_blogs_ClarityGovConToplineResults [https://perma.cc/643K-DSTG]. Deltek reports average fringe-benefit costs of twenty-eight percent, average general and administrative expense rates of fifteen percent, and an average composite overhead expense rate of thirty-nine percent. *Id.* at 26. These numbers imply that the full cost of employee time is roughly 2.04 times ($1.28 \times 1.15 \times 1.39$) an employee's base salary. *See id.*; *see also* Hyam Singer, *Don't Be Fooled: Calculate the Real Cost of Employees and Consultants*, TOPTAL, https://www.toptal.com/freelance/don-t-be-fooled-the-real-cost-of-employees-and-consultants (last visited Jan. 6, 2019) [https://perma.cc/TR4R-SBRF] (calculating a multiple of 1.99 based on a prior Deltek report). There may be reason to believe that the relevant multiplier in the case of the Patent Office is lower than this amount. After all, the vast majority of patent examiners employed by the Agency telecommute from their homes, saving considerable overhead costs. U.S. PATENT & TRADEMARK OFFICE, *supra* note 1, at 91, 94. Nonetheless, to be conservative, we select a multiplier implied by the Deltek averages.

The Patent Office conducted a regulatory impact analysis with respect to rulemaking to set and adjust patent fees that are economically significant in 2013. U.S. PATENT & TRADEMARK OFFICE, REGULATORY IMPACT ANALYSIS: SETTING AND ADJUSTING PATENT FEES IN ACCORDANCE WITH SECTION 10 OF THE LEAHY-SMITH AMERICA INVENTS ACT (Jan. 18, 2013), https://www.uspto.gov/sites/default/files/aia_implementation/AC54_Final_Regulatory_Impact_Analysis.pdf [https://perma.cc/T4ZX-D9N5]. In this analysis, the Agency estimated that hiring 1,500 additional patent examiners would cost the Patent Office $154 million in terms of "long-term cost of compensation and benefits in the out years." *Id.* at 53. This would suggest a multiplier of approximately 1.3, assuming the distribution of patent examiners in Table 6.

doubling the amount of time extended to examiners will cost the Agency $660 million per year.

TABLE 6: SIMULATED INCREASE IN PAYROLL EXPENSES ASSOCIATED WITH DOUBLING THE NUMBER OF HOURS ALLOCATED TO EXAMINERS

	(1)	(2)	(3)	(4)	(5)
GS-level	**Number of Annual Dispositions by Examiners**	**Mean Number of Hours Assigned**	**Total Additional Hours After Doubling Hours per Application**	**Examiner Cost per Hour (Salary, Benefits, and Other Costs)**	**Extra Costs When Doubling Examination Hours**
GS-5	237	36.3	8,603	$31.41	$270,200
GS-7	3,244	28.7	93,103	$38.90	$3,621,325
GS-9	9,870	26.0	256.620	$47.57	$12,207,762
GS-11	20,770	23.5	488,095	$57.58	$28,102,895
GS-12	41,825	21.5	899,238	$68.99	$62,041,828
GS-13	85,747	18.2	1,560,595	$82.05	$128,043,432
GS-14	254,931	16.3	4,155,375	$96.96	$402,920,694
GS-15	12,432	16.5	205,128	$114.05	$23,394,541
Total	430,056	17.9	7,666,757	$76.58	$660,602,677

The mean number of hours per GS-level is calculated over the 2016 Patent Application Information Retrieval ("PAIR") sample after assigning hour allotments to each application in the PAIR database based on the associated technology group and examiner GS-level.

IV. THE PATENT OFFICE IS IRRATIONALLY IGNORANT

This Part summarizes our empirical findings from Parts II and III and compares the potential savings and costs associated with doubling patent examiner time allocations. Because the litigation and prosecution savings associated with increasing the Patent Office resources outweigh the costs associated with increasing the examiner's time allocations, we conclude that society would be better off investing more resources ex ante in the review of patent applications. That is to say, we conclude the opposite of Lemley. Given its current level of resources, the Patent Office is not being "rationally ignorant" but, instead, *irrationally ignorant*. This Part closes by outlining the key differences between our findings and Lemley's, noting that Lemley's assumptions understated the potential savings and overstated the potential costs associated with doubling patent examiner time allocations.

A. The Patent Office Resources Should Be Increased

To summarize our empirical analysis, we simulate that by doubling the amount of hours allocated to review applications, the amount of additional costs to the Agency will be roughly $660 million annually. We estimate federal litigation savings of $491 million and PTAB litigation savings of $112 million. We also estimate that increasing examiner time allocations will result in $301 million in savings in prosecution expenses to the patent applicant, driven by decreased rounds of reviews at the Patent Office. Though the $660 million increase in costs is significant, this amount is still exceeded by the $904 million that may be saved annually in (1) expenses covering litigation in federal court, (2) PTAB-related legal expenses, and (3) potential savings in prosecution costs.[144]

Moreover, this excess of savings over costs would only grow if we were able to quantify what are likely to be substantial additional social costs stemming from the issuance of invalid patents that will either never be invalidated in court or that will be invalidated with a delay. The conservative nature of our comparison strategy is only strengthened by our decision to exclude these additional savings from our direct comparison.[145]

Lemley famously noted that the Patent Office is "rationally ignorant."[146] Based on the above empirical analysis, we do not agree with Lemley's contention that the present state of affairs is "rational." On the contrary, the present degree of ignorance—that is, the limited ability of examiners to unearth prior art and hence reject patent applications that fail to meet the patentability standards—is *irrational*. In other words, the current level of resources the Patent Office extends to review patent applications is insufficient.

144. *See supra* Part II.

145. Quantifying those additional savings would become more critical if the increased expenses associated with augmenting patent examiner time allocations were greater than the saved litigation expenses.

146. *See* Lemley, *supra* note 3. By "ignorant," he referred to the inability of examiners, at least in some cases, to fully apply the patentability requirements during the limited time they were allotted for review—e.g., their inability to discover that a claimed innovation was not, in fact, novel. *Id.* at 1508–09. When looking at the present structure of the examination process, we do not necessarily take issue with Lemley's use of the term "ignorant." Patent examiners indeed appear to be allowing a notable degree of patents that would likely fail a stricter examination if examiners were given greater resources.

B. Key Differences Between Our Findings and Lemley's

This Section delineates how we reach the opposite outcome than Lemley. More specifically, we find that Lemley overstated the costs associated with increasing patent examiner time allocations and understated the savings associated with augmenting the time examiners review patents.

First, Lemley assumed that if the amount of time patent examiners spent reviewing an application was doubled, the Patent Office would issue ten percent fewer patents.[147] Based on that assumption, Lemley then assumed that litigation costs would decrease by ten percent if the time allocations of patent examiners were doubled.[148] Unlike Lemley, we do not simply guess a particular value for these parameters. Rather, we draw on rich microlevel application data and estimate an empirical model meant to isolate the relationship between examination time allotments on the one hand and either grant rates or reduced litigation events on the other hand. To be clear, our analysis is not without assumptions of its own. Virtually no empirical exercise could escape such a requirement. In our case, as we exhaustively discuss and support in our prior peer-reviewed research that developed these methods,[149] we are assuming that the comparisons of outcomes across applications assigned to examiners at different GS-levels indeed illuminate the effects of varying time allocations to examiners (after accounting for the range of controls included in the regression specification). We acknowledge that there is still room to challenge our assumption in this regard; nonetheless, we have endeavored with this exercise to go far beyond merely assuming the value of the key parameter itself.

Ultimately, but perhaps not surprisingly, our estimation approach delivers a different value for these parameters than those assumed by Lemley. In particular, our analysis suggests that both of Lemley's assumed values are too low, thus downplaying the total potential savings from greater ex ante investment in examination review. To begin, as set forth in the Online Appendix and as summarized in Section II.A.2, by doubling the amount of examination hours, we predict that patent grant rates will fall by roughly 27%, not 10%, as Lemley assumed.[150] For the reasons theorized above, this reduction in patent issuances would be expected to lead to less

147. *Id.*

148. *Id.* at 1509–10.

149. Frakes & Wasserman, *supra* note 12.

150. *See* Online Appendix, *supra* note 9, at 4–9; *see also supra* Section II.A.2.

subsequent litigation. It is also important to note that greater examination time may improve issued patent quality in ways that are not solely captured by a reduced grant rate—e.g., greater time may also help examiners narrow the claim scope of patents that would have issued either way. Perhaps due to a combination of these claim-narrowing effects and the reduced-patent-issuance effects, our regression estimates demonstrate that a doubling of examination time for a given application leads to a 44% reduction in the expected litigation expenses associated with that application.

This litigation-savings estimate is considerably larger than the ten percent effect assumed by Lemley, and that difference holds meaningful implications for our ultimate conclusion. If we were to replicate the litigation savings from Table 3 but use Lemley's assumptions, we would predict that the amount of federal litigation savings would equal only $147 million (discounted to $126 million). This amount, even when combined with the PTAB and prosecution savings, would no longer exceed the $660 million in necessary additional expenditures associated with doubling examination time. Thus, at least when focusing on our comparison of institutional costs—litigation, PTAB, and prosecution savings versus agency administrative expenses—we reach a different conclusion from Lemley, in part, due to our ability to actually estimate the degree of litigation savings ensuing from a doubling of examination hours.

Another notable difference between our calculation and Lemley's stems from differences in our respective estimates of the effect of augmenting examiner time allocations on patent prosecution legal charges. Lemley assumed (without estimating) that doubling the time examiners review patent applications will result in a fifty percent increase in legal fees associated with prosecuting patents.[151] He reasoned that because patent examiners will have more time for review, they will find more prior art and make more rejections, in which event the responding attorney will need to spend more time reviewing and responding to the additional rejections.[152] Lemley set the costs associated with prosecuting an original patent application at $20,000 (and a repeat-filed application at $5,000), meaning that for each original application filed it would cost $10,000 more to prosecute (and for a repeat-filed application, an additional $2,500).[153] Because currently over 430,000 applications are disposed of annually, of which

151. Lemley, *supra* note 3, at 1508.

152. *Id.* at 1508 n.7.

153. *Id.* at 1508.

approximately 40% are repeat filers,[154] the increased legal charges associated with doubling time allocations under Lemley's assumption are just over $3 billion (assuming no inflation in prosecution costs).[155] If Lemley's assumption regarding prosecution costs is correct, then our ultimate conclusion would change. But we believe that this amount vastly overestimates the increased legal fees associated with augmenting patent examiner time allocations. In fact, our estimate suggests these fees are in the wrong direction altogether.

Although we agree that examiners may make higher-quality rejections if given more time to review patent applications, as discussed in Section II.B, it is theoretically unclear whether this would increase or decrease the aggregate legal fees associated with prosecuting patents. The empirical evidence set forth in Section II.B suggests a large potential savings in these fees. More specifically, we find there is little change in per-office-action fees resulting from an increase in time allocations, lending little support to the supposition that prosecution rates would increase. Most saliently, our findings that the number of rounds of review would likely *decrease* upon augmenting examiner time allocations supports the notion that patent applicants could experience substantial savings—not costs—due to stronger ex ante investment in the Patent Office. In particular, we estimate that doubling examiner time allocations would result in a $301 million savings to patent prosecution legal fees.

V. OBJECTIONS

This Part begins by addressing objections to the calculations laid out in Parts II through IV. Some might question the costs and savings

154. Frakes & Wasserman, *supra* note 7, at 627 (noting that forty percent of applications filed in 2012 were repeat filings).

155. Technically, Lemley assumed patent application filings would decrease by ten percent in response to enhanced examination at the Patent Office. Lemley, *supra* note 3, at 1509. Thus, his estimated prosecution costs would be $2.7 billion, not $3 billion. *See id.* Either way, if Lemley's assumption regarding increased prosecution costs is correct, our ultimate conclusion would be altered.

On this point, in our own estimates of the amount of litigation savings and additional personnel expenses stemming from doubling examination hours, we do not assume that the number of annual dispositions will fall as a result of additional ex ante investment in the Patent Office. What if we were to assume, as Lemley did, that applications will fall by ten percent in the process? First, recall that the number of annual application dispositions by the Patent Office is a key direct input into our estimates of both the costs and savings of investing more in the Patent Office, as discussed in Parts II and III. Scaling that input down by ten percent will, in turn, scale down both sides of our fundamental comparison. Accordingly, this assumption will only affect the size of the differential between costs and savings that we predict, not the direction of that differential.

we choose to incorporate while others might argue that the focus on legal costs fails to account for distributional effects.

A. Failure to Account for a Full Range of Costs and Benefits

We do not, and cannot possibly, account for all the costs and savings associated with increasing patent examiner review times. We noted this previously when indicating our inability to quantify the additional savings that may arise from reduced deadweight losses from monopoly pricing, reduced harms to follow-on innovation, and other such factors. Given the lack of relevant empirical data on these other savings, we have chosen to take a conservative approach by considering *only* litigation and prosecution savings. In contrast, the estimate of costs associated with increasing examiner time allocations is more comprehensive and more likely to include the full range of costs. Our limited ability to consider potential savings does not affect our conclusion that the Patent Office is irrationally ignorant. If the litigation and prosecution savings alone justify spending more resources at the Patent Office, considering the full range of savings would only make the case more compelling.

Although we are more confident that our estimation of potential costs is more comprehensive than our estimation of potential savings, admittedly, we, like Lemley, only consider first-order costs and savings associated with increasing examiner time allocations. There are undoubtedly second-order costs and savings associated with giving examiners more time to do their jobs. By second-order, we refer to subsequent effects that may arise in response to the effects of time-allocation increases already discussed.

Many second-order effects, however, are difficult to quantify even with empirical guidance. For instance, the Patent Office may need to increase its fees in an effort to fund the increased personnel expenses set forth in Part III. Higher examination fees could result in the filing of fewer patent applications. On the one hand, fewer filings could be a reflection of less underlying innovation. The added cost associated with receiving a patent on a new invention—as a result of the heightened fees—may induce an innovator to forgo pursuing that invention in the first place. On the other hand, it may be the case that the foregone invention is of dubious legal merit anyway—e.g., perhaps what is foregone are efforts to develop a technology that is already known to the world. To the extent that increased Patent Office fees discourage innovative efforts of this more dubious nature, the result may be one that enhances social welfare. There is some support from economic

theory that increases in fees would first impact these less groundbreaking innovations.[156]

Other secondary effects are even more difficult to quantify. For instance, companies sued for patent litigation must often involve scientists and researchers in their litigation efforts—e.g., to participate in depositions and to provide litigation support—which can crowd out their research and development efforts.[157] Of course, while these research-related effects may be difficult to quantify, were we to incorporate them, it would only increase our estimated savings levels and thus reinforce our analysis. Alternatively but relatedly, the costs associated with hiring additional patent examiners could be larger than we suggested. Because a scientific degree is necessary to become a patent examiner, examiners are almost always trained scientists and engineers. Is society better off placing scientists in private companies to work on innovations or in the Patent Office to review applications?

This is a difficult question, which, at least today, is nearly impossible to answer.[158] Nonetheless, given the litany of conservative assumptions we have made along the way and the theoretical ambiguity as to whether these second-order considerations will increase or decrease the net savings to society, we have little reason to believe that

156. Mark Schankerman & Florian Schuett, *Screening for Patent Quality: Examination, Fees, and the Courts* (Tilburg Law & Econ. Ctr., Discussion Paper No. 2016-036, 2016), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2885197 [https://perma.cc/7M2Z-GR75].

As a result, if we were to incorporate a consideration of the effect of Patent Office fee changes into our cost-benefit analysis, the result could either strengthen or weaken our ultimate conclusion. Nonetheless, studies to date have suggested that small increases to patent-examination fees have a negligible effect on the volume of patent filings. *See* Gaetan de Rassenfosse & Bruno van Pottelsberghe de la Potterie, *On the Price Elasticity of Demand for Patents*, 74 OXFORD BULL. ECON. & STAT. 58, 58–77 (2011); Timothy K. Wilson, *Patent Demand—A Simple Path to Patent Reform*, 2 INT'L IN-HOUSE COUNSEL J. 806, 810–12 (2008) (arguing that filing fees need to be raised significantly in order to reach the elastic portion of the demand curve). Accordingly, even if fee levels increased to accommodate the required personnel expenses, it is not clear that we would see a meaningful change in applicant behavior in the first place. Given this empirical insight from the existing literature on the elasticity of applicant behavior to fee levels, we have elected not to model these effects altogether.

157. Stephen Kiebzak, Greg Rafert & Catherine E. Tucker, The Effect of Patent Litigation and Patent Assertion Entities on Entrepreneurial Activity (June 16, 2015) (unpublished manuscript), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2457611 [https://perma.cc/2JWL-TGVH] (finding a U-shaped relationship between U.S. venture capital investment and the number of litigated patents).

158. Despite this difficulty, we acknowledge the possibility of observing productivity and/or innovation declines elsewhere in society as a result of increasing the Patent Office workforce. But it is important to keep in mind that by expanding the personnel capacity of the Patent Office, we are likely to improve the quality and the efficiency of the patent examination process. This may only increase the returns to patenting and to innovative activity, which may, in turn, attract more individuals into science and research in the first place. Given both the theoretical ambiguity in the direction of any such effect and the difficulty in estimating these responses, we accordingly do not incorporate them into our cost-benefit comparison.

our failure to account for these second-order effects will alter the ultimate implications of our analysis.[159]

B. Distributional Effects

This Article has not yet discussed any distributional considerations associated with the fundamental question of whether we should rely more on ex ante screening or ex post litigation for patent invalidation purposes. Stated more generally, we have not yet addressed the question of who in society should bear the marginal costs associated with screening valid from invalid patents. The costs involved are, of course, not trivial, and the benefits that derive from the screening of valid from invalid patents are felt by the general public. For both of these reasons, it may enhance both equity and efficiency if the costs associated with screening invalid patents were to be spread across a large base, rather than being concentrated on a small group of individuals in society.[160]

159. Moreover, even if we were to double the number of examiners at the Patent Office, this would only entail the hiring of an additional eight thousand individuals. This is perhaps trivial next to the size of the overall workforce employed as either scientists or engineers in the United States. For instance, consider the number of people employed in the following positions in the United States in 2016: chemical engineers (32,700), electrical and electronics engineers (324,600), civil engineers (303,500), mechanical engineers (288,800), industrial engineers (257,900), environmental engineers (53,800), computer hardware engineers (73,600), nuclear engineers (17,700), petroleum engineers (33,700), aerospace engineers (69,600), biomedical engineers (21,300), medical scientists (120,000), biochemists and biophysicists (31,500), microbiologists (23,200), agricultural and food scientists (43,000), computer and information research scientists (27,900), chemists and materials scientists (96,200), environmental scientists and specialists (89,500), geoscientists (32,000), physicists and astronomers (19,900), and atmospheric scientists (10,400), among others. For these statistics and more information regarding workforce size, see U.S. BUREAU OF LABOR STATISTICS, U.S. DEP'T OF LABOR, OCCUPATIONAL OUTLOOK HANDBOOK, https://www.bls.gov/ooh (last modified April 13, 2018) [https://perma.cc/CE69-57RX].

160. Basic economic theory suggests that, generally, the more one loads the financing of a public good onto one source—e.g., through taxation—the higher the extent of deadweight losses stemming from the necessary taxation. It is generally more efficient to spread those financing burdens more broadly. *See* JONATHAN GRUBER, PUBLIC FINANCE AND PUBLIC POLICY 204–08 (5th ed. 1993). Moreover, this outcome would likely align with considerations of equity to the extent that we see a greater correspondence between the group of individuals benefiting from this policy and the group of individuals financing this policy.

An assumption that we have made thus far in this discussion is that the public at large is indeed the group that benefits from a proper screening of valid from invalid patents. But is that assumption altogether clear? After all, it is undeniable that patent owners are the primary beneficiaries of obtaining a patent. They may be able to charge monopoly prices for their invention, reaping significant rents during the period of the exclusivity. At the same time, the patent system's primary goal is to promote innovation, and society, not just the patent applicant, benefits from the fruits of such innovation. Without a mechanism such as the patent system to recoup their research and development expenses, innovators may choose not to innovate at all, which would be unquestionably bad for society. Moreover, once this system is in place, society at large stands to lose should patent protection be extended to invalid patents, in which event society gains from investing greater resources to ensure that these determinations are made accurately.

One might be concerned that adopting the ex ante approach would too narrowly focus the costs of screening invalid patents on patent applicants. However, it may be premature to conclude that the costs of greater ex ante investment are actually concentrated on a smaller section of society. First, *all* applicants pay application (and other) fees to the Patent Office, whereas only a small subset of those innovators will ultimately be involved in litigation. Moreover, the full incidence of application fees may fall on a much broader base—i.e., patent holders may pass those costs onto their customers via higher prices. Finally, even if it were the case that the full incidence of the fees paid to the Agency did not sufficiently fall on a broad enough portion of the population, it is also important to note that a push toward greater ex ante investment at the Patent Office could also be combined with a retreat from full user-fee funding of the Patent Office. That is, one could fund some amount of the additional personnel expenses needed to expand examination time through general tax revenue—which would be directly spread across a wide base—rather than user fees.[161]

All told, it is simply unclear whether one approach—ex ante versus ex post—trumps the other from a distributional point of view. Accordingly, even though the analysis in Parts II through IV largely focuses on a comparison of aggregate costs and aggregate savings, we do not believe that a consideration of distributional factors of this nature would fundamentally alter our contention that society would benefit from investment in greater resources devoted to patent examination at the Patent Office.

VI. REFORM PROPOSALS

So far, this Article has focused on whether it is more efficient to increase the time examiners spend reviewing patent applications to weed out more bad patents or to reserve a larger role for the courts to invalidate improvidently issued patents. We conclude that the Patent Office should give serious thought to augmenting the time allocations of patent examiners given that Part IV demonstrated that the benefits

161. Congress, however, would have to provide the Patent Office with a sufficient budget to cover its growing examination demands, which is hardly a given. In the past, Congress has routinely utilized Patent Office fees to fund other governmental activities, even when the Agency's resource health was in question. Frakes & Wasserman, *supra* note 140, at 77–78. Furthermore, mounting concerns over the federal government's fiscal cliff suggest that funding the Agency through taxes may not result in the Patent Office receiving sufficient resources to process its growing backlog of patent applications. One of the primary drivers behind Congress's increased reliance on user fees to finance agencies has been the belief that such a funding mechanism increases the resource sustainability of the Agency, especially in the current environment of deficit containment.

associated with increasing the time examiners evaluate applications outweigh the costs. This Part provides some specifics as to how the Agency should augment examiner time allocations.

There is a question, of course, as to how the Agency should go about augmenting review time. Should examiners be given more time across the board, or should the Patent Office enact a more nuanced approach? That is, while expanding time allotments, should we also reconsider the manner in which those allotments vary over an examiner's career? We argue for the latter. Instead of advocating that the Agency should give all examiners a set increase in hours for review, we suggest that the Agency should target its time expansion efforts more heavily on higher GS-level examiners.

As discussed in Section I.A, our previous work found that examiner grant rates increase by roughly 13% to 29% as an examiner rises from GS-level 7 to GS-level 14, a progression wherein examination times are cut in half. While decreasing hour allotments upon promotion is prudent—after all, seasoned and proven examiners are likely to complete a review of an application faster than an examiner who has yet to demonstrate this competency—our prior research suggests the rate at which the Patent Office decreases time allocations upon examiner promotion should be reconsidered.[162] Our estimates of significantly higher grant rates upon reaching higher GS-levels suggest that the current scaling of the time allotments upon promotion is too aggressive and leaves applicants with an inequitable outcome. Applicants that, by chance, happen to receive an examiner with an aggressive time schedule (i.e., a higher GS-level), will face a much higher likelihood of success relative to applicants that, by chance, happen to receive an examiner with a more forgiving schedule.

As a result, we propose that the Patent Office not only give all examiners more time to review patent applications but that the Agency target those time expansions more heavily on the higher GS-level examiners. In other words, the time allocations of a GS-level 12 patent examiner reviewing applications in a given technology should be increased more than the time allocations of a GS-level 11 patent examiner reviewing applications in the same technology. Increasing examiner time allocations will help improve the quality of patents issued by the Agency. To the extent that these adjustments will create a more homogenous pattern of grant rates across examiners, such a change would increase the equity of the patent examination system, as similar applicants would be more likely to have similar patent office outcomes.

162. *See supra* Section I.A.

Finally, we note that this analysis does not speak to whether other proposals to improve Patent Office decisionmaking should be implemented. For instance, our prior work argued that the Agency's fee schedule should be modified to eliminate a financial incentive to grant patents.[163] Others have proposed Patent Office reforms to increase the clarity of issued claims.[164] Still others, including us, have suggested limiting the number of times a patent applicant can refile the same application.[165] These suggestions may be good ideas, but a separate cost-benefit analysis must be conducted before concluding as such.

CONCLUSION

This Article confronts a classic regulatory dilemma: Should society increase the resources at the Patent Office in an effort to increase the quality of issued patents, or should society reserve a larger residual role for the courts to invalidate bad patents? Mark Lemley famously favored the latter, arguing that the costs associated with increasing examiner time allocations outweighed the benefits of doing so. This Article conducts a similar cost-benefit analysis to the one that Lemley attempted over fifteen years ago, but does so by employing new and rich sources of data along with sophisticated empirical techniques to form novel, empirically driven estimates of relationships that Lemley was forced, given the dearth of empirical evidence at the time, to simply assume in his own analysis. Armed with these new estimates, this Article demonstrates that the savings associated with giving examiners additional time per application outweigh the costs of doing so. We thus conclude that given its current level of resources, the Patent Office is not being "rationally ignorant" but, instead, *irrationally ignorant*.

163. Frakes & Wasserman, *supra* note 140, at 76–80.

164. *See* Peter S. Menell & Michael M. Meurer, *Notice Failure and Notice Externalities*, 5 J. LEGAL ANALYSIS 1, 33–34 (2013) (describing a "wish list" of recommendations that would clarify the claims process, such as requiring applicants to designate a default dictionary); Peter S. Menell, *Promoting Patent Claim Clarity*, BERKELEY TECH. L.J. (May 10, 2016), http://btlj.org/2016/05/promoting-patent-claim-clarity [https://perma.cc/2YZQ-4J3J] (suggesting the use of a patent claim template).

165. *See* Frakes & Wasserman, *supra* note 7, at 672 (arguing to limit the number of repeat applications an applicant can file in an effort to abolish a pro-granting bias at the Patent Office); Mark A. Lemley & Kimberly A. Moore, *Ending Abuse of Patent Continuations*, 84 B.U. L. REV. 63 (2004) (arguing to limit the number of repeat filings).

Online Appendix to Irrational Ignorance at the Patent Office

Michael D. Frakes
Melissa F. Wasserman

A. Bounded Analysis of Increase in Payroll Expenses Associated with Doubling the Number of Hours Allocated to Examiners

In this Section of the Appendix, we discuss a bounded analysis of the personnel costs to the Patent Office ("the Agency") that result from doubling patent examiner time allocations. In particular, we adopt different multipliers to account for the full cost of a patent examiner to the Patent Office in excess of their base salary. As discussed in Section II.A, we assume a 2.04 factor of an employee's base salary to account for fringe benefits, employer taxes and insurance, and allotments for office space, rent, equipment, replacement/turnover cost, managerial support, etc. Below, we repeat the calculation in Table 2 of the Article but utilize a multiplier factor of 2.5 (Table A1) to provide a high estimate and a multiplier factor of 1.5 (Table A2) to provide a low estimate of the increase in payroll expenses associated with doubling examiner time allocations.

TABLE A1: SIMULATED INCREASE IN PAYROLL EXPENSES ASSOCIATED WITH DOUBLING THE NUMBER OF HOURS ALLOCATED TO EXAMINERS UTILIZING 2.5 MULTIPLIER FOR FULL COSTS

	(1)	(2)	(3)	(4)	(5)
GS-level	**Number of Annual Dispositions by Examiners**	**Mean Number of Hours Assigned**	**Total Additional Hours After Doubling Hours per Application**	**Examiner Cost per Hour (Salary, Benefits, and Other Costs)**	**Extra Costs when Doubling Examination Hours**
GS-5	237	36.3	8,603.1	$38.30	$329,512.66
GS-7	3,244	28.7	93,102.8	$47.67	$4,416,249.66
GS-9	9,870	26.0	256.6	$58.30	$14,887,515.12
GS-11	20,770	23.5	488,095.0	$70.56	$34,274,823.28
GS-12	41,825	21.5	899,237.5	$84.55	$75,660,765.91
GS-13	85,747	18.2	1,560,595.0	$100.55	$156,150,526.46
GS-14	254,931	16.3	4,155,375.0	$118.82	$491,366,699.51
GS-15	12,432	16.5	205,128.0	$139.77	$28,529,927.49
Total	430,056	17.9	7,666,757.0	$93.85	$805,613,020.24

The mean number of hours per grade is calculated over the 2016 PAIR sample after assigning hour allotments to each application in the PAIR database based on the associated technology group and examiner grade level.

TABLE A2: SIMULATED INCREASE IN PAYROLL EXPENSES ASSOCIATED WITH DOUBLING THE NUMBER OF HOURS ALLOCATED TO EXAMINERS UTILIZING 1.5 MULTIPLIER FOR FULL COSTS

	(1)	(2)	(3)	(4)	(5)
GS-level	**Number of Annual Dispositions by Examiners**	**Mean Number of Hours Assigned**	**Total Additional Hours After Doubling Hours per Application**	**Examiner Cost per Hour (Salary, Benefits, and Other Costs)**	**Extra Costs when Doubling Examination Hours**
GS-5	237	36.3	8,603.1	$22.98	$197,707.60
GS-7	3,244	28.7	93,102.8	$28.60	$2,649,749.80
GS-9	9,870	26.0	256.6	$34.98	$8,932,509.07
GS-11	20,770	23.5	488,095.0	$42.34	$20,563,093.97
GS-12	41,825	21.5	899,237.5	$50.73	$45,396,459.55
GS-13	85,747	18.2	1,560,595.0	$60.33	$93,690,315.88
GS-14	254,931	16.3	4,155,375.0	$71.29	$294,820,019.71
GS-15	12,432	16.5	205,128.0	$83.86	$17,117,956.49
Total	430,056	17.9	7,666,757.0	$56.31	$483,367,812.15

The mean number of hours per grade is calculated over the 2016 PAIR sample after assigning hour allotments to each application in the PAIR database based on the associated technology group and examiner grade level.

This bounded analysis provides that doubling the amount of time extended to examiners will cost the Agency $483 million to $805 million per year.

B. Estimation of Reduction of Number of Patents Granted Annually Due to Doubling of Examination Time Allotments

In this Section of the Appendix, we discuss the methodology that we employ to predict the amount by which grant rates will fall subsequent to a doubling of the amount of time extended to patent examiners in addition to the total amount of reduced patent grants each year stemming from such an expansion in examination time allocations.

For these purposes, we use the dataset discussed in Part III of the Article. With this information, we estimate the following empirical specification out of the resulting microlevel sample of patent applications:

$$GRANT_{aikt} = \alpha + \boldsymbol{\gamma_i} + \boldsymbol{\lambda_t} + \boldsymbol{\partial_k} + \boldsymbol{\beta_1}(\mathbf{GS}_{it}) + \boldsymbol{\beta_2}(\mathbf{EXPER}_{it}) + \boldsymbol{\beta_3}\mathbf{X}_{aikt} + \varepsilon_{aikt} \quad (1)$$

where a indexes the individual application, i indexes the individual examiner, k indexes the technology associated with the application, and t indexes the year in which the application is disposed of by the examiner. $GRANT_{aikt}$ indicates whether or not the given application was allowed by the examiner. Year fixed effects are captured by $\boldsymbol{\lambda_t}$ and art unit fixed effects are captured by $\boldsymbol{\partial_k}$, each accounting for fixed differences in granting practices across years and across art units.[1] $\mathbf{GS}_{it}$ represents a set of variables capturing the incidence of the examiner assigned to the underlying application falling into each of the general schedule ("GS") pay-grade levels. We drop examiners in GS-level 5 from this analysis because there are too few in the sample—only 7,000 applications out of 3.9 million. We also drop GS-level 15, as most examiners transition into a purely supervisory role when reaching GS-level 15 and no longer primarily examine applications. Some GS-level 15 examiners still review occasional applications but given the substantial change in the nature of the job at this level, we do not trace the evolution of practices past GS-level 14. The GS-level 7 dummy variable is dropped from the regression itself, allowing GS-level 7 examiners to serve as the reference group. $\mathbf{EXPER}_{it}$ captures a set of dummy variables for the incidence of the relevant examiner falling into a range of experience-level categories, where experience is signified by the number of years (in two-year bins) at the time of the application's disposition that the relevant examiner has been with the Patent Office. Included in $\mathbf{X}_{aikt}$ is an indicator variable for the incidence of a large entity applicant.

Examiner fixed effects are captured by $\boldsymbol{\gamma_i}$. Such effects help address concerns that more experienced examiners and higher GS-level examiners are fundamentally different in their granting tendencies from their more junior counterparts—e.g., concerns that examiners who have reached higher grade levels and thus who have been successful in attaining promotions may be those with a stronger inherent disposition toward granting in the first place. Instead, with this framework, we track the granting practices of individual examiners as they themselves experience the indicated GS-level promotion.

This specification essentially attempts to estimate the relationship between grant rates and the amount of time given to examiners. In particular, we take a relatively nonparametric approach

1. Art units are organizational groups within the Patent Office to which patent examiners are assigned. Art units generally consist of between eight and twenty examiners and are organized along technology lines. Applications are generally randomly assigned to examiners within each art unit. The amount of time allocated to examiners are a function of the art unit to which they belong and their GS-level. By including art unit fixed effects, this approach forces us to draw on variation in GS-levels to derive variation in examination time allotments.

in this regard and focus on the relationship between an examiner's grant rate and the occurrence of various GS-level promotions that carry with them reductions in time allocations, while accounting for various factors—such as experience—that could potentially confound this relationship. To determine the effect of a doubling of examination time, we would then focus on the coefficient of the GS-level 14 level dummy variable, as (i) this coefficient captures how much higher an examiner's grant rate is at GS-level 14 relative to what it was at GS-level 7 (while accounting for year effects, experience effects, etc.) and (ii) time allocations are roughly half as large at GS-level 14 relative to GS-level 7.

In unreported alternative estimations, we take a more parametric approach to determining the relationship between examination time allocations and grant rates, though one that is more straightforward in presentation. In this alternative, for each application, we assign a variable, *Hours*, equal to the number of hours allocated to the examiner assigned to the application, which is a function of the art unit to which the examiner is assigned and the GS-level of the examiner. We then estimate the coefficient of this *Hours* variable. Given the inclusion of examiner fixed effects and art unit fixed effects, this approach essentially draws on changes in time allocations that arise only through GS-level promotions. As such, it is in the exact same spirit as the specification in equation (1) except that it essentially fits a linear relationship between hours and grant rates—e.g., it treats a move from six to seven hours of time allocation as the same as the move from fourteen to fifteen hours and from thirty-two to thirty-three hours.

We present the results from our estimation of equation (1) in Table A3.

TABLE A3: RELATIONSHIP BETWEEN EXAMINER GS-LEVELS AND THE INCIDENCE OF A PATENT APPLICATION BEING GRANTED (MEAN GRANT INCIDENCE = 0.70)

	(1)
(Omitted: GS-7)	
GS-9	0.048***
	(0.004)
GS-11	0.074***
	(0.004)
GS-12	0.096***
	(0.005)
GS-13	0.130***
	(0.005)
GS-14	0.192***
	(0.006)
N	3,912,905

Estimates marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively. Standard errors are reported in parentheses and are clustered to correct for autocorrelation within given examiners over time. Each observation is a given application from the PAIR database that reached a final disposition and that was published in the PAIR records between March 2001 and June 2017. The regression includes examiner fixed effects, art unit fixed effects, examiner experience group fixed effects (in two-year bins), and a dummy variable indicating whether or not the application was filed by a large entity.

C. Estimation of Reduction of Number in Patent-Lawsuit Pairs Annually Due to Doubling of Examination Time Allotments

We now discuss the methodology that we employ to predict the amount by which litigation will fall subsequent to a doubling of the amount of time extended to patent examiners. This Section of the Appendix essentially formalizes the discussion of the empirical methods employed in Part III of the Article. For a description of the data underlying this exercise, we refer the reader to Part III of the Article.

Using the individual application-level data discussed in Part III, we estimate the following conditional negative binomial regression model:

$$\mu_{aikt} = \exp(expose + \boldsymbol{\lambda_t} + \boldsymbol{\partial_k} + \boldsymbol{\beta_1}(\mathbf{GS}_{it}) + \boldsymbol{\beta_2}(\mathbf{EXPER}_{it}) + \boldsymbol{\beta_3}(\mathbf{TENURE}_i) + \boldsymbol{\beta_4}(\mathbf{COHORT}_i) + \boldsymbol{\beta_5}\mathbf{X}_{aikt})) \quad (2)$$

where a, i, k, t, GS, $\mathbf{EXPER}$, $\boldsymbol{\lambda_t}$, $\boldsymbol{\partial_k}$, and $\mathbf{X}_{aikt}$ are as above. The expected number of times that a given patent application will wind up the subject of a patent lawsuit (over the litigation tracking period discussed in Part III of the Article) is expressed by μ_{aikt}. We also refer to this as the

expected number of patent-lawsuit pairs, bearing in mind that a given patent can be asserted in multiple lawsuits and that a given lawsuit often involves multiple patents.

TENURE represents a series of binary dummy variables that capture the incidence of the examiner associated with the given application falling into different groups based on the amount of time the examiner ultimately spends with the Patent Office, where tenure groups are organized into two-year bins. This allows us to control for the fact that examiners who depart from the Patent Office early in their careers may fundamentally differ in the quality of their reviews relative to examiners who stay at the Patent Office for a long time.

COHORT represents a series of dummy variables that capture the year in which the examiner first began working at the Patent Office. This allows us to control for fixed differences in the nature of examination practices across examiners based on the year in which they were hired. These differences may arise, for instance, due to changes over time in the training practices of the Patent Office or to changes over time in the examination culture of the Agency, which may have especially long-lasting impacts on new and impressionable hires at the Agency (leading to hiring cohort effects). In prior work, we demonstrated the critical importance of cohort dynamics in explaining examiner behavior.[2]

We did not include cohort and tenure effects in the grant-rate specification, as they were subsumed by the examiner fixed effects. We do not include examiner fixed effects with this litigation-savings analysis because doing so while also accounting for art unit effects and estimating a negative binomial regression over nearly four million applications would simply be too unwieldly. Nonetheless, the cohort and tenure effects (in addition to the other controls) go a long way toward accounting for the heterogeneity across examiners. The pattern of results from the grant-rate specifications are nearly identical when estimating examiner fixed effects specifications and when instead including hiring-year cohort and tenure effects.

Expose captures an exposure variable for the negative binomial regression and equals the amount of time left between the present and the year in which the application was disposed. This accounts for the fact that applications disposed of in 2002 had a longer time period to experience a litigation event relative to applications disposed of in 2014.

2. Michael D. Frakes & Melissa. F. Wasserman, *Patent Office Cohorts*, 65 DUKE L.J. 1601, 1602 (2016).

D. Estimation of Reduction of Examination Review Rounds Due to Doubling of Examination Time Allotments

Table A4 presents results from an empirical specification identical to that estimated in Table A3, but where the dependent variable equals the number of office action rounds that occur for the application. This variable captures the degree of back and forth between the examiner and the applicant, where the specification is meant to estimate the extent to which that back and forth goes down (or up) as examiners are given more (or less) time. Given the small number of zeroes in this outcome variable across the observations, we elect as our primary approach to estimate an Ordinary Least Squares regression model as we do in Table A3, which also allows us to include examiner fixed effects. We note, however, that these results are nearly identical when instead estimating a negative binomial model similar to that set forth in equation (2).

TABLE A4: RELATIONSHIP BETWEEN EXAMINER GS LEVELS AND THE NUMBER OF OFFICE ACTIONS

	(1)
	OLS RESULTS
(Omitted: GS-7)	
GS-9	0.345***
	(0.013)
GS-11	0.622***
	(0.018)
GS-12	0.839***
	(0.021)
GS-13	0.879***
	(0.024)
GS-14	0.789***
	(0.027)
N	3,831,210

Estimates marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively. Standard errors are reported in parentheses and are clustered to correct for autocorrelation within given examiners over time. Each observation is a given application from the PAIR database that reached a final disposition and that was published in the PAIR records between March 2001 and June 2017. The regression includes examiner fixed effects, art unit fixed effects, examiner experience group fixed effects (in two-year bins), and a dummy variable indicating whether or not the application was filed by a large entity.

If we were to use these estimates of reduced rounds of review from doubling examination time to estimate the amount of saved

prosecution costs, we would likely estimate nearly $1 billion in savings annually (considering the number of annual dispositions, the average number of reduced rounds of review, and the prosecution costs associated with each round of review). This would overwhelmingly reinforce the conclusions of our Article. We hesitate to make a prediction so large, however, given one caveat with the estimation underlying Table A4. The average number of office actions for each application in our sample is 2.6, with at least 10% of applications having over 5. One might be concerned that the increases in office actions with GS-level changes documented in Table A4 are driven by increases in rounds of review during the later stages of these long application processes. This is potentially concerning, as it may not reflect an impact of time allocations but instead may result somewhat mechanically from changes in the application sample throughout the GS-level progression. That is, those applications with especially large numbers of rounds of review are those applications that remain under review for many years. Applications of this sort may be less represented among the set of applications disposed of by examiners while they are still at lower GS-levels considering that examiners may have been promoted to higher GS-levels by the time those applications are disposed of. Perhaps those dynamics alone might explain why we observe more rounds of review with GS-level promotions.

We attempt to address this concern in Table A5 by limiting the sample to those applications that undergo at most three office actions before disposition—a set of applications that will not disproportionately be disposed of by examiners at upper GS-levels. As demonstrated by Table A5, the results change very little, which suggests that the increases in office action churn by GS-level changes is perhaps driven by changes in office action counts at earlier stages of the examination processes, appeasing the above-stated sample-selection concerns and thereby continuing to suggest that by giving examiners less time to review applications, the Patent Office may be encouraging office action churn and thus greater rounds of review. In turn, this suggests that by giving examiners more time, we may reduce the number of rounds of review and thereby save prosecutorial expenses associated with responding to office actions.

TABLE A5: RELATIONSHIP BETWEEN EXAMINER GS-LEVELS AND THE NUMBER OF OFFICE ACTIONS, CONDITIONAL ON LESS THAN THREE OFFICER ACTIONS PER APPLICATION

	(1)
	OLS RESULTS
(Omitted: GS-7)	
GS-9	0.259***
	(0.008)
GS-11	0.438***
	(0.010)
GS-12	0.491***
	(0.011)
GS-13	0.511***
	(0.012)
GS-14	0.562***
	(0.012)
N	2,826,018

Estimates marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively. Standard errors are reported in parentheses and are clustered to correct for autocorrelation within given examiners over time. Each observation is a given application from the PAIR database that reached a final disposition and that was published in the PAIR records between March 2001 and June 2017. The regression includes examiner fixed effects, art unit fixed effects, examiner experience group fixed effects (in two-year bins), and a dummy variable indicating whether or not the application was filed by a large entity.

Why might it be the case that by giving examiners more time to review applications, we may see a reduction in the number of rounds of review that is perhaps driven by less churn in the earlier rounds of review, as opposed to in the later rounds of review? To answer this question, we turn to a discussion from one of our recent papers.[3] In that work, we started by observing that examination time expectations are tied to productivity expectations, where those productivity expectations are monitored over quota periods. In particular, examiners are expected to hit biweekly workload goals and quarterly workload goals. If examiners delay in their productive efforts over this quota period, then they will be forced to rush to hit their productivity targets at the end of those periods, provided they are sufficiently motivated to hit those targets. In our prior work, we theorized that in these moments of end-of-quota rush and in the case of their first office actions for given applications, examiners may be incentivized to issue uninformative and

3. Michael D. Frakes & Melissa F. Wasserman, Procrastination in the Workplace: Evidence from U.S. Patent Examiners (unpublished manuscript) (on filed with authors).

easily-overcome rejections—known as "shotgun" rejections—which can be executed in a short period of time. This strategy gives examiners the option to correct these ill-informed and possibly incorrect rejections at a later moment, when they are able to actually give the application appropriate attention. In our prior work, we documented evidence of a substantial amount of shotgun rejections and indeed found that examiners were able to direct the appropriate level of attention to those applications at some point in a later round of review, in which case we documented little difference in ultimate disposition outcomes between those applications that experienced a rush at the end of the quota period during their first round of review relative to those first round reviews that experienced no rush. We concluded that the real consequence of these shotgun rejections is thus examination delay. In other words, one can view that rushed first office action as a wasted round of review that must be made up in subsequent rounds.

To be sure, this story originates from a specific kind of time constraint—i.e., a rush at the end of a quota period—whereas the present Article pertains to the amount of time given to review the application as a whole. But bear in mind that when examiners are given less time to review applications as whole, they are effectively expected to hit higher quota counts. In this light, if examiners mismanage their time during quota periods (as supported by our prior work)[4] and if they are given higher quota counts, they may be more likely to find themselves in an end-of-quota rush and thus more likely to waste a round of review with a "shotgun" rejection.

In a final empirical check, we attempt to lend further support to this shotgun-rejection theory by drawing on insights from our previous research.[5] In our prior work, we developed a marker suggestive of a wasted first round review. Specifically, we flagged whether or not the examiner issued a "nonfinal" rejection on the second round—i.e., a rejection in which they state new grounds for rejection not previously identified in the first round. One can effectively view this as an admission of an inadequate first round of review. Typically, in second office actions, examiners will instead either allow the application or issue a "final" rejection that does not set forth different bases of rejection from the first round (of course, this rejection is not technically "final" in that applicants can use certain tools to continue with the same application). In Table A6, we supplement the analyses from Tables A4 and A5 and test the relationship between GS-level promotions and the

4. *Id.*
5. *Id.*

incidence of a nonfinal, second office-action rejection. This approach also avoids the concerns raised above over the fact that low-GS-level examiners may not dispose of applications that undergo a high number of rounds of review; after all, examiners throughout all GS-levels review second office actions.

TABLE A6: RELATIONSHIP BETWEEN EXAMINER GS-LEVELS AND THE INCIDENCE OF A NONFINAL, SECOND-OFFICE ACTION REJECTION

	(1)
	OLS RESULTS
(Omitted: GS-7)	
GS-9	0.024***
	(0.002)
GS-11	0.036***
	(0.002)
GS-12	0.042***
	(0.003)
GS-13	0.039***
	(0.003)
GS-14	0.029***
	(0.004)
N	3,914,313

Estimates marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively. Standard errors are reported in parentheses and are clustered to correct for autocorrelation within given examiners over time. Each observation is a given application from the PAIR database that reached a final disposition and that was published in the PAIR records between March 2001 and June 2017. The regression includes examiner fixed effects, art unit fixed effects, examiner experience group fixed effects (in two-year bins), and a dummy variable indicating whether or not the application was filed by a large entity.

Table A6 suggests that as examiners are given less time to review applications, they are more likely to issue nonfinal, second office-action rejections. Again considering that nonfinal, second office-action rejections may be seen as an empirical marker for a wasted first round of review, this finding is consistent with the idea that if the Agency gives examiners more time to review applications, we may see fewer wasted rounds of review, a development that would lead to potential savings in prosecution costs. There are a couple of important things to note from the results presented in Table A6. First, the magnitude of the reduced number of rounds of review implied by this nonfinal, second office-action rejection analysis is less than that implied by the direct estimates of reduced rounds from Tables A4 and A5. This is perhaps, in part, due to the fact that the Patent Office looks negatively on these

occurrences, leaving some examiners less inclined to articulate new bases of rejections in the second round, perhaps instead hoping to do so after the applicant has filed a Request for Continuing Examination and moved on to subsequent rounds. Second, we acknowledge that nonfinal, second office-action rejections start to decline once examiners reach GS-level 13 and GS-level 14, though they are still more likely as compared to the lowest GS-levels. This, in part, may be due to some reduction in supervision that comes from GS-level 13 and GS-level 14 promotions specifically, as we discuss in much greater depth in our prior work.[6] That is, in the course of their time at GS-level 13, some examiners acquire the right to independently sign off on their own first office actions. Examiners acquire the right to sign off on all aspects of their review upon reaching GS-level 14. The fact that these supervisory changes occur specifically for these two promotions does not compromise our entire GS-level methodology in that supervisory changes do not occur in all promotions that change examination time, as we have discussed previously. In the context of a salient admission of poor first-round work product, however, one might not be surprised to see that examiners will become less inclined to make such an admissions when not under the shadow of someone signing off on their reviews.

All told, we fail to find any evidence at all to support any suggestion that examinations will experience a greater number of rounds of back-and-forth between applicants and examiners when examiners are given more time. If anything, we find to the contrary—i.e., that greater examination time may lead to less office churn.

E. Estimation of Federal Litigation Costs

To determine the average litigation costs associated with a patent-lawsuit pair, we draw on information from three sources: (1) the annual Report of the Economic Survey from the American Intellectual Property Law Association ("AIPLA Surveys"), which provides annual breakdowns of average litigation costs associated with cases, broken down by stages of litigation reached and by amounts at stake in the lawsuit; (2) a recent working paper by Christopher Cotropia and colleagues, *A Granular Analysis of Civil Litigation*,[7] which examines

6. Michael D. Frakes & Melissa F. Wasserman, *Is the Time Allocated to Review Patent Applications Inducing Examiners to Grant Invalid Patents?: Evidence from Micro-Level Application Data*, 99 REV. ECON. & STAT. 550 (2017).

7. Christopher A. Cotropia, Jay P. Kesan, Kyle Rozema & David L. Schwartz, A Granular Analysis of Civil Litigation (Aug. 2018) (unpublished manuscript) (on file with authors).

docket entries of sixteen thousand patent infringement lawsuits and, among other things, assesses the distribution of case terminations across different stages of trial; and (3) data on patent infringement lawsuits from the Lex Machina database with information on the resulting damages for those suits with damages awards.

Ultimately, our goal is to derive an expected litigation costs amount in light of the distribution of case costs along different combinations of: (1) amounts at stake in the cases and (2) stages of the lawsuit completed. We derive the necessary probabilities for this distribution from the Cotropia et al. paper and from the Lex Machina data, while deriving the associated expenses from the AIPLA Surveys. Prior to 2017, these latter surveys provide median litigation expenses for defending lawsuits separately depending on whether the suit reached the end of discovery or whether it culminated with a trial judgement. In 2017, they added a separate category and presented costs associated with completing initial case management.

In the Cotropia et al. paper, we learn that 41% of suits fail to reach this case management stage (though most (79%) at least reach the point where the defendant answers the complaint). This raises the first question that we confront in this analysis: How much in litigation expenses do we assign to these 41% of suits considering that the AIPLA Surveys do not provide costs associated with suits that terminate just prior to this case management stage? It would be inaccurate to assume that the litigation expenses associated with these suits are $0. After all, most entailed at least an answer to the compliant, and for those settled, there would be litigation expenses associated with settlement. Accordingly, we proceed by assuming that the litigation expenses occurred for cases in this category are half of those reported by the AIPLA for those completing case management.

Next, we note that since the data we use to form predictions of the number of patent-case pairs that may be eliminated by doubling examination time comes from applications disposed of and case outcomes between 2001 and 2017, we aim to draw on the costs reported by the AIPLA over that time period (though nonetheless converted to today's dollars). While the AIPLA only began to report cost amounts for suits ending at case management in 2017, we can attempt to impute the amount for earlier years by observing how the other reported costs—which were reported over the entire time period—change over time and scaling appropriately.

The second important category of costs reported by the AIPLA are usually phrased as litigation expenses through the end of discovery. With the latest report, the AIPLA clarifies that this is inclusive of

discovery, motions and claim construction. The Cotropia et al. paper reports that roughly 12.1% of cases reach a claim construction ruling. This presents the next important question for our purposes. This means that 47% of cases are terminated following a case management hearing but prior to the point of claim construction. The AIPLA, however, only reports costs for cases up to the point of case management and up to point of claim construction, not in between. However, Cotropia and colleagues demonstrate that out of those 59% of cases that at least reach case management, most will continue for many more months before terminating—i.e., most cases that reach case management do not simply terminate at that point. On average, following the point of case management, cases will spend an additional twenty-one months before terminating (with a median of fourteen months post-case management). As such, while the majority of these cases do not go all the way to the point of claim construction, many likely proceed many months into the discovery process, likely incurring additional expenses. Given these duration statistics from Cotropria and collegues, we elect to assign litigation expenses for those cases that at least reach case management but that fail to reach claim construction equal to the average of the case management and claim construction/end-of-discovery costs reported by the AIPLA.

Next, we consider those set of cases that at least reach claim construction but do not reach trial. According to Cotropia and colleagues, this group characterizes 7.9% of all suits. Cotropia and colleagues report that, conditional on reaching the claim construction stage, suits will spend on average roughly 20.9 months post-claim construction until termination (with a median of sixteen months post-claim construction). Given this distribution of time-to-disposition post-claim construction, for those suits that at least reach claim construction but do not proceed to trial, we assign litigation costs equal to the average of the end-of-discovery and full-trial costs reported by the AIPLA.

Next, we consider the remaining 4.2% of cases that reach trial. For these cases, we assign litigation costs equal to the full-trial costs reported by the AIPLA.

The next important consideration involves the amount at stake in litigation. The AIPLA reports litigation expenses (by stage of suit completion) separately for the following groups: (1) less than $1 million at stake, (2) $1–$10 million, (3) $10–$25 million, and (4) $25+ million. Unfortunately, we are aware of no data source that indicates the distribution of amounts at risk for the full set of cases involving some litigation. Easier to obtain, of course, is data on the distribution of

damages across cases that have at least some damages awards. Such information is available from the Lex Machina database. With this distribution, we can place a lower bound on the percent of cases that at least have greater than $1 million at stake. That is, if we assume all cases that do not culminate in a damages award have less than $1 million at stake, we know that at least 3% to 4% of all cases filed have greater than $1 million at stake, since at least this amount culminates in a judgment with damages exceeding $1 million. Similarly, we know that at least 1% to 2% of all cases filed have at least greater than $10 million at stake, since at least this amount culminates in a judgment with damages exceeding $10 million.

In our baseline estimates, however, we try not to simply rely on these lower bounds, as that may be giving away too much. Surely, some amount of those cases filed that do not culminate in an observable damages award have amounts at stake greater than $1 million. The key question is how many. One might surmise that the distribution of damages levels among those receiving some damages is informative here, in which event roughly 45% of cases would have amounts at stake exceeding $1 million, 24% of cases would have amounts at stake exceeding $10 million, and 16% of cases would have amounts at stake exceeding $25 million. The problem with this, of course, is that those cases that reach a judgment with damages may not be representative of all cases filed when it comes to the question of how much is at stake. After all, cases with more at stake may be more likely to reach the trial stage in the first place, considering that there is greater room for divergent party expectations—and thus failed settlements—when potential damages are greater. Of course, this then leaves a substantial gulf between these lower and upper bounds. That is, the percentage of cases with amounts at stake greater than $1 million is somewhere between 4% and 45% of cases. For our purposes, we take what we hope is a conservative approach and assume that the right answer for the full set of filed cases is a quarter of the way between these two bounds. That is, we assume that at least 14% of cases have over $1 million at stake, at least 7% of cases have over $10 million at stake, and at least 4% of cases have over $25 million at stake.

Let us make one important final note regarding the AIPLA numbers. The AIPLA cost estimates are one-sided only, in that they only use costs associated with defending a suit, thereby omitting costs associated with the parties asserting the underlying patents. For the expected litigation costs that we present, however, we attempt to present total expected costs inclusive of both plaintiff and defendant expenses. For these purposes, we assume that the plaintiff costs match

those of the defense. Supporting this assumption, the 2015 AIPLA economic survey indicated that a majority of its survey respondents reported that assertion costs are the same as defense costs.

Putting this all together, we set forth the following table that demonstrates: (1) the various possible combinations of amounts at stake and litigation stages, (2) the probabilities associated with the relevant combination, and (3) the litigation costs associated with that combination. From these, we derive the expected amount of litigation costs per case, which comes out to $539,949.30. Bear in mind that each patent case may be associated with more than one underlying patent. Since our empirical analysis in the text is designed to predict the number of patent-case pairs that may be reduced by giving examiners additional examination time, we also endeavor to derive the expected litigation costs associated with a given patent-case pair. This final step is relatively straightforward—we simply divided the above estimate by the average number of patents per case throughout our sample period (2.3), using data from Lex Machina for such purposes. Doing so, we estimate an expected litigation cost per patent-case pair of $234,760.60.

On a final note, we acknowledge that this analysis rests heavily on the cost estimates from the AIPLA. While this is the best source available for our purposes, we acknowledge that our analysis may be inaccurate depending on the validity of the survey results reported by the AIPLA.

TABLE A7: EXPECTED LITIGATION COSTS PER PATENT AND PER PATENT-CASE PAIR

		(1)	(2)	(3)
		Probability Distribution	**Litigation Costs (P and D), Conditional on Indicated Combination of Amounts at Stake and Stage of Litigation**	**Expected Litigation Costs (Column 2 x Column 3)**
Amount at Stake	**Stage of Litigation**	-	-	-
<$1 million (86% of cases)	Pre-case management (41%)	0.353	$40,000	$14,104.00
	Post-case management, no claim construction (46.9%)	0.403	$440,000	$177,469.60

	Claim construction, no trial (7.9%)	0.068	$1,100,000	$74,734.00
	Trial (4.2%)	0.036	$1,400,000	$50,568.00
$1–$10 million (7% of cases)	Pre-case management (41%)	0.029	$100,000	$2,870.00
	Post-case management, no claim construction (46.9%)	0.033	$1,050,000	$34,471.50
	Claim construction, no trial (7.9%)	0.006	$2,950,000	$16,313.50
	Trial (4.2%)	0.003	$4,000,000	$11,760.00
$10–$25 million (3% of cases)	Pre-case management (41%)	0.012	$172,000	$2,115.60
	Post-case management, no claim construction (46.9%)	0.014	$2,072,000	$29,153.04
	Claim construction, no trial (7.9%)	0.002	$5,000,000	$11,850.00
	Trial (4.2%)	0.001	$6,200,000	$7,812.00
>$25 million (4% of cases)	Pre-case management (41%)	0.016	$238,000	$3,903.20
	Post-case management, no claim construction (46.9%)	0.019	$3,238,000	$60,744.88
	Claim construction, no trial (7.9%)	0.003	$8,000,000	$25,280.00
	Trial (4.2%)	0.002	$10,000,000	$16,800.00
Total Expected Litigation Costs per Case	-	-	-	$539,949.30
Total Expected Litigation Costs per Patent-Case Pair	-	-	-	$234,760.60

F. Bounded Analysis with Respect to Federal Litigation Costs

In this Section of the Appendix, we discuss a robustness exercise in which we place bounds on the savings in federal litigation costs that may arise from doubling patent examiner time allocations. In particular, we relax assumptions associated with both (1) how we

account for the associated expenses for those cases that terminate *between* the three major case milestones documented by Cotropia and colleagues and for which the AILPA Surveys provide annual breakdowns of average litigation costs and (2) how we treat the distribution of the amounts at stake in the cases. Again, from the Cotropia et al. paper, we learn that 59% of suits reach the case management stage, 12.1% of suits reach the end of discovery/claim construction ruling, and 4.2% of suits reach trial. In our baseline specification, we proceed by assuming that the litigation expenses occurred for cases that fail to meet the case management stage is half of those reported by the AIPLA for those completing case management, that the litigation expenses occurred for cases that terminated following a case management hearing but prior to the point of claim construction are equal to the average of the case management and claim construction/end-of-discovery costs, and that the litigation expenses occurred for cases that terminated following claim construction ruling but prior to the point of trial are equal to the average of the end-of-discovery and full-trial costs reported by the AIPLA. In Table A8, we repeat the calculation from Table A7 but assume for those cases that terminate in between major case milestones that litigation expenses are equal to a quarter of the way between the costs associated with the two cabining milestones (Table A8) to provide a low estimate of litigation savings and three quarters of the way between the costs associated with the two cabining milestones (Table A9) to provide a high estimate of the costs reported by the AIPLA for the cabining case milestones.

TABLE A8: EXPECTED LITIGATION COSTS PER PATENT AND PER PATENT-CASE PAIR ASSUMING THAT LITIGATION EXPENSES FOR THOSE CASES THAT TERMINATE IN BETWEEN MAJOR CASE MILESTONES ARE ONE-FOURTH OF THE WAY BETWEEN THE COSTS FOR THE CABINING CASE MILESTONES

		(1)	(2)	(3)
		Probability Distribution	**Litigation Costs (P and D), Conditional on Indicated Combination of Amounts at Stake and Stage of Litigation**	**Expected Litigation Costs (Column 2 x Column 3)**
Amount at Stake	**Stage of Litigation**	-	-	-
<$1 million (86% of cases)	Pre-case management (41%)	0.353	$20,000	$7,052.00

	Post-case management, no claim construction (46.9%)	0.403	$220,000	$88,660.00
	Claim construction, no trial (7.9%)	0.068	$550,000	$37,367.00
	Trial (4.2%)	0.036	$1,400,000	$50,568.00
$1–$10 million (7% of cases)	Pre-case management (41%)	0.029	$50,000	$1,435.00
	Post-case management, no claim construction (46.9%)	0.033	$525,000	$17,235.25
	Claim construction, no trial (7.9%)	0.006	$1,475,000	$8,156.75
	Trial (4.2%)	0.003	$4,000,000	$11,760.00
$10–$25 million (3% of cases)	Pre-case management (41%)	0.012	$86,000	$1,057.80
	Post-case management, no claim construction (46.9%)	0.014	$1,036,000	$14,576.52
	Claim construction, no trial (7.9%)	0.002	$2,500,000	$5,925.00
	Trial (4.2%)	0.001	$6,200,000	$7,812.00
>$25 million (4% of cases)	Pre-case management (41%)	0.016	$119,000	$1,951.60
	Post-case management, no claim construction (46.9%)	0.019	$1,619,000	$30,372.44
	Claim construction, no trial (7.9%)	0.003	$4,000,000	$12,640.00
	Trial (4.2%)	0.002	$10,000,000	$16,800.00
Total Expected Litigation Costs per Case	-	-	-	$313,444.70
Total Expected Litigation Costs per Patent-Case Pair	-	-	-	$136,280.29

TABLE A9: EXPECTED LITIGATION COSTS PER PATENT AND PER PATENT-CASE PAIR ASSUMING THAT LITIGATION EXPENSES FOR THOSE CASES THAT TERMINATE IN BETWEEN MAJOR CASE MILESTONES ARE THREE-FOURTHS OF THE WAY BETWEEN THE COSTS FOR THE CABINING CASE MILESTONES

		(1)	(2)	(3)
		Probability Distribution	**Litigation Costs (P and D), Conditional on Indicated Combination of Amounts at Stake and Stage of Litigation**	**Expected Litigation Costs (Column 2 x Column 3)**
Amount at Stake	**Stage of Litigation**	-	-	-
<$1 million (86% of cases)	Pre-case management (41%)	0.353	$60,000	$21,156.00
	Post-case management, no claim construction (46.9%)	0.403	$660,000	$266,204.40
	Claim construction, no trial (7.9%)	0.068	$1,650,000	$112,101.00
	Trial (4.2%)	0.036	$1,400,000	$50,568.00
$1–$10 million (7% of cases)	Pre-case management (41%)	0.029	$150,000	$4,305.00
	Post-case management, no claim construction (46.9%)	0.033	$1,575,000	$51,707.30
	Claim construction, no trial (7.9%)	0.006	$4,425,000	$24,470.30
	Trial (4.2%)	0.003	$4,000,000	$11,760.00
$10–$25 million (3% of cases)	Pre-case management (41%)	0.012	$258,000	$3,173.40
	Post-case management, no claim construction (46.9%)	0.014	$3,108,000	$43,729.60
	Claim construction, no trial (7.9%)	0.002	$7,500,000	$17,775.00
	Trial (4.2%)	0.001	$6,200,000	$7,812.00

>$25 million (4% of cases)	Pre-case management (41%)	0.016	$357,000	$5,854.80
	Post-case management, no claim construction (46.9%)	0.019	$4,857,000	$91,117.30
	Claim construction, no trial (7.9%)	0.003	$12,000,000	$37,920.00
	Trial (4.2%)	0.002	$10,000,000	$16,800.00
Total Expected Litigation Costs per Case	-	-	-	$766,454.00
Total Expected Litigation Costs per Patent-Case Pair	-	-	-	$333,240.86

Second, in our baseline specification, we also assume a distribution of amounts at risk in a lawsuit that is a quarter between the lower bound and upper bound estimates. The AIPLA reports litigation expenses (by stage of suit completion) separately for the following groups: (1) less than $1 million at stake, (2) $1–$10 million, (3) $10–$25 million, and (4) $25+ million. Unfortunately, we are aware of no data source that indicates the distribution of amounts at risk for the full set of cases involving some litigation. Thus, as described above, we utilized data on the distribution of damages across cases that have at least some damages awards to place lower and upper bounds of the amounts at risk in a lawsuit. In Tables A10 and A11, we replicate our calculations from Table A7 above but utilize the lower (Table A10) and upper bound estimates (Table A11) of the distribution of amounts at risk.

TABLE A10: EXPECTED LITIGATION COSTS PER PATENT AND PER PATENT-CASE PAIR UTILIZING THE LOWER BOUND ESTIMATE OF THE DISTRIBUTION OF AMOUNTS AT RISK

		(1)	(2)	(3)
		Probability Distribution	**Litigation Costs (P and D), Conditional on Indicated Combination of Amounts at Stake and Stage of Litigation**	**Expected Litigation Costs (Column 2 x Column 3)**
Amount at Stake	**Stage of Litigation**	-	-	-
<$1 million (96.2% of cases)	Pre-case management (41%)	0.39442	$40,000	$15,776.80
	Post-case management, no claim construction (46.9%)	0.4512	$440,000	$198,518.32
	Claim construction, no trial (7.9%)	0.07600	$1,100,000	$83,597.80
	Trial (4.2%)	0.0404	$1,400,000	$56,565.60
$1–$10 million (2% of cases)	Pre-case management (41%)	0.0082	$100,000	$820.00
	Post-case management, no claim construction (46.9%)	0.00938	$1,050,000	$9,849.00
	Claim construction, no trial (7.9%)	0.00158	$2,950,000	$4,661.00
	Trial (4.2%)	0.00084	$4,000,000	$3,360.00
$10–$25 million (1.3% of cases)	Pre-case management (41%)	0.00533	$172,000	$916.76
	Post-case management, no claim construction (46.9%)	0.006097	$2,072,000	$12,632.98
	Claim construction, no trial (7.9%)	0.001027	$5,000,000	$5,135.00
	Trial (4.2%)	0.000546	$6,200,000	$3,385.20
>$25 million (0.5% of cases)	Pre-case management (41%)	0.0205	$238,000	$487.90
	Post-case management, no	0.02345	$3,238,000	$75,93.11

	claim construction (46.9%)			
	Claim construction, no trial (7.9%)	0.00395	$8,000,000	$3,160.00
	Trial (4.2%)	0.0021	$10,000,000	$2,100.00
Total Expected Litigation Costs per Case	-	-	-	$408,559.47
Total Expected Litigation Costs per Patent-Case Pair	-	-	-	$177,634.55

TABLE A11: EXPECTED LITIGATION COSTS PER PATENT AND PER PATENT-CASE PAIR UTILIZING THE UPPER BOUND ESTIMATE OF THE DISTRIBUTION OF AMOUNTS AT RISK

		(1)	(2)	(3)
		Probability Distribution	**Litigation Costs (P and D), Conditional on Indicated Combination of Amounts at Stake and Stage of Litigation**	**Expected Litigation Costs (Column 2 x Column 3)**
Amount at Stake	**Stage of Litigation**	-	-	-
<$1 million (55% of cases)	Pre-case management (41%)	0.2255	$40,000	$9,020.00
	Post-case management, no claim construction (46.9%)	0.25795	$440,000	$113,498.00
	Claim construction, no trial (7.9%)	0.04345	$1,100,000	$47,795.00
	Trial (4.2%)	0.0231	$1,400,000	$32,340.00
$1–$10 million (21% of cases)	Pre-case management (41%)	0.0861	$100,000	$8,610.00
	Post-case management, no claim construction (46.9%)	0.09849	$1,050,000	$103,415.50

	Claim construction, no trial (7.9%)	0.01659	$2,950,000	$48,941.50
	Trial (4.2%)	0.00882	$4,000,000	$35,280.00
$10–$25 million (8% of cases)	Pre-case management (41%)	0.328	$172,000	$56,416.00
	Post-case management, no claim construction (46.9%)	0.3752	$2,072,000	$777,414.40
	Claim construction, no trial (7.9%)	0.0632	$5,000,000	$316,000.00
	Trial (4.2%)	0.0336	$6,200,000	$208,320.00
>$25 million (16% of cases)	Pre-case management (41%)	0.0656	$238,000	$15,612.80
	Post-case management, no claim construction (46.9%)	0.07504	$3,238,000	$242,979.52
	Claim construction, no trial (7.9%)	0.01264	$8,000,000	$101,120.00
	Trial (4.2%)	0.00672	$10,000,000	$67,200.00
Total Expected Litigation Costs per Case	-	-	-	$2,183,961.72
Total Expected Litigation Costs per Patent-Case Pair	-	-	-	$949,548.14

G. Estimation of Legal Costs Associated with PTAB Proceedings

Critical to our analysis is also the need to determine legal savings related to the Patent and Trial Board ("PTAB") giving examiners more time to review applications. Necessary for such purposes is an estimation of the average legal expenses associated with a PTAB proceeding. To derive this estimate, we likewise turn to the annual Report of the Economic Survey of the AIPLA. The AIPLA likewise reports different costs depending on the stage of the PTAB proceeding reached upon its termination. Our PTAB records suggest that roughly seventy-five percent of PTAB proceedings are instituted. For those twenty-five percent of petitions that are filed but not instituted, we assess legal costs of $80,000 per side, as reported by the AIPLA surveys. For the remainder, we assess costs of $275,000, using

the AIPLA cost figures for "through PTAB hearing." These figures thus imply that the average PTAB petition filed will garner costs of $226,250 per side, or $452,500 total.