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, **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.