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The America Invents Act**

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Patent Validity Challenges

and The America Invents Act^{*}

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Abstract: Patent reexamination or patent review systems can lower the cost of challenging patent validity and help improve patent quality. We empirically investigate post-grant patent validity challenges at the U.S. Patent and Trademark Office, and how the 2011 America Invents Act affected them. We compare the inter partes reexamination with the inter partes review procedure that replaced it after the reform. To identify the effect of the policy changes, we exploit the fact that patents filed before the act passed, but granted after the new inter partes review system took effect, are not eligible for reexamination in the old system. We find that more patent challenges end with a patentee win after the policy change. Still, at least one patent claim is canceled in more than 60% of the cases. Challenged patents issued to small entities more often had at least one claim canceled compared to other patents.

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1. Introduction

For some time, scholars have expressed significant concerns over the quality of patents granted in the United States. They have referred to the patent system as “broken” (Jaffe and Lerner, 2004), and have wondered “what to do about bad patents?” (Lemley, Lichtman and Sampat, 2006). Others have even proposed abolishing the patent system altogether (Boldrin and Levine, 2013). The United States Patent and Trademark Office has itself recognized the importance of patent quality, noting that “High-quality patents enable certainty and clarity of rights, which fuels innovation and reduces needless litigation.”¹

As one measure aimed at improving patent quality, several patent systems in the world allow third parties (in particular, accused infringers) to challenge the validity of granted patents in administrative proceedings. The decision makers in these proceedings are housed within the patent system and deal predominately or exclusively with patent validity cases. Compared to traditional litigation, this degree of specialization could resolve challenges more quickly, more cheaply, and more accurately. Such procedures could help eliminate bad patent claims and increase the quality of the pool of already-granted patents.

In 1999, the United States introduced inter partes reexamination (IPX), which for the first time allowed third parties to actively challenge patent validity at the patent office. In 2011, the America Invents Act substantially reformed these procedures. Effective September 2012, the AIA discontinued the inter partes reexamination system, and replaced it with a new system, inter partes review (IPR).² Because these administrative procedures are relatively new, not much is known about how they function or the effects of the recent reform.

¹ See <http://www.uspto.gov/patent/initiatives/enhanced-patent-quality-initiative-0> last accessed 05/25/2018.

² The new system also includes a post grant review option that is limited to the first 9 months after patent grant. We do not include post grant reviews.

In this paper, we present an empirical analysis of validity challenges at the U.S. patent office. We study the characteristics of patents that survive a challenge, and the effects of the recent policy reform on the outcomes of these challenges. We compiled a new dataset that consists of patent validity challenges from 10/10/2010 to 08/24/2014. It includes both IPX and IPR challenges to allow a comparison between the two systems. We added to this dataset observations of other litigated patents (not challenged in these procedures) to allow us to account for sample selection.

Inter partes reexamination was slow to catch on, but gradually grew in importance. Administrative patent challenges became even more popular since the AIA; the number of patents challenged under IPR each year is several times greater than those challenged under IPX. While under both systems, challenges are predominantly used as a tool alongside litigation,³ the new review procedure differs from the previous reexamination process in a number of ways. Notably, IPR costs more, is quicker and is more similar to a trial (see Section 3 for more details). Whereas before the policy change reexamination was handled by patent examiners, since the AIA, IPRs are conducted by the Patent Trial and Appeal Board (PTAB).

As the use of administrative validity challenges has grown, so too has the controversy surrounding these procedures. The PTAB has been referred to as a patent “death squad”, accused of having anti-patent slant and harming innovators. (See for example Levy, 2015, Morinville, 2016 and comments to their articles in IPWatchdog). We examine the effect of the policy change, and find no evidence that the policy change introduced a negative bias against the patentee in reexamination.

³ 76% of IPX requests were for patents known to be in litigation according to USPTO statistics at <http://uspto.gov/learning-and-resources/statistics>. Likewise, an October 2015 study found that “over 80% of IPR filings were associated with co-pending federal court litigation” (Cutler 2015).

Since the AIA reform, the share of patent challenges that end in a “patentee win” has actually increased from about 22% to 36% of patent challenges.⁴ There are some differences in the characteristics of patents challenged before and after the policy change, including an increase in the average number of claims and in the composition of patent categories. Controlling for observed patent characteristics, we still find that patentees are more likely to win a patent challenge case after the policy change.

Since we cannot observe and control for all patent characteristics, two challenges arise in estimating the effect of the policy change: 1. Close to the policy change, some petitioners could have selected between the two systems. 2. Patent challengers could choose to challenge validity in district court, or settle, instead of using the existing administrative procedures, IPX or IPR. If selection patterns are different after the policy change, then the coefficient of IPR in the outcome regression could also capture this change. To overcome these challenges, we use an instrumental variable approach to account for the potential endogeneity of the IPR variable, and we utilize a Heckman (1979)-style estimation procedure to test and control for sample selection. Accounting for these potential biases, we continue to find an increase in patentee wins.

We are also interested in comparing patent challenge outcomes for patents assigned to small entities to the outcomes of other challenges. Scholars have stressed the importance of small inventors to our economy (see for example Lanjouw and Schankerman, 2004). The share of small entity patents is the same in both systems. Challenged small entity patents are less likely to end with a patentee win, as compared to those issued to other patentees. This could indicate that these patents are of lower quality compared to other reexamined patents. Or, it could be that these

⁴ We explain the construction of our “patentee win” variable in detail in Section 4. In essence, we view a patentee win as a challenge where all challenged claims are denied review or confirmed. Any cancelled claims would be a patentee loss under this definition.

patentees are less able to defend their patent in reexamination. Our finding complements a similar result reported in Allison et al. (2011). The authors found that when the cases do not settle, patents originally issued to small entities are significantly less likely to win in trial or judgement.

The remainder of this paper proceeds as follows. In Section 2, we review existing literature on post-grant validity challenges and on small entities. In Section 3, we provide background information on IPX, IPR, and the change in policy introduced by the AIA. In Section 4, we describe how we constructed the dataset and in Section 5, we make preliminary descriptive observations. In Section 6, we present the results of our study; we compare the challenge system before the AIA policy change (IPX) to the patent review system after the policy change (IPR). In Section 7 we account for the potential endogeneity of the policy indicator and the possibility of selection bias. Section 8 considers appeals, settlements and denials as possible explanations for the increase in patentee wins, and Section 9 offers concluding remarks.

2. Related Literature

Economics literature surrounding patent challenges has been relatively scarce, perhaps due to the somewhat infrequent use of patent reexamination in the United States, especially in the early years. Hall et al. (2004) provide a broad background on challenging a patent's validity post-issue. The authors compare the U.S. reexamination process to that of the European Patent Office, and conclude that there are welfare gains to be had by improving U.S. post-grant opposition and avoiding litigation costs. Chiou (2006) argues that a third party with invalidating prior art could collude with the patentee to share monopoly power.

Graham et al. (2003) compare patent opposition in the European Patent Office (EPO) with USPTO patent reexaminations in the '80s and '90s, in the technology categories of biotechnology and pharmaceuticals, and semiconductors and computer software. In both patent offices, valuable

patents are more likely to be challenged and European oppositions are more frequent than U.S. reexaminations. Graham and Harhoff (2014) propose revising the U.S. reexamination system to resemble the EPO post-grant review system. The authors predict a range of welfare gains in the billions of dollars, due to the revocation of bad patents and avoided litigation costs.

Reexamination trends and practices have received greater attention in the law literature. Gardella and Berger (2009) discuss the use of reexamination as a strategic tool by alleged infringers to stay pending litigation. They predict that success in the reexamination system will cause patent holders to file narrower patents that are less likely to be invalidated in these proceedings. In a recent contribution, Vishnubhakat et al. (2016) study how litigants use inter partes review and covered business method review. They find that the majority of inter partes review validity challenges are brought by district court defendants. Bar and Costello (2018) identify predictors of administrative patent challenges.

One of our main results involves patents issued to small entities, a class of patentees that has been investigated in prior literature. Lanjouw and Schankerman (2004) find that patentees with small patent portfolios run a higher risk of litigation. Gallaso and Schankerman (2015) show that invalidation of patents owned by large firms triggers more follow-on innovation by small firms, and Gallaso and Schankerman (2018) show that a loss of patent rights significantly increases the likelihood of exit for small firms. These contributions highlight the importance of outcomes of patent challenges for small entities.

3. Background on Patent Challenges at the USPTO

Historically, administrative procedures to challenge patent validity were not available in the United States. Starting in 1981, third parties could petition the patent office to reexamine a patent, however, these requests were *ex parte* - third parties were not able to actively participate in

the challenge.⁵ The only way for a third party to actively challenge a patent's validity was through district court litigation. Often, this happens defensively; a third party alleged to have infringed a patent will attempt to render infringement moot by proving that the patent was invalid to begin with.

In 1999, the American Inventors Protection Act (AIPA) created an administrative proceeding - inter partes reexamination (IPX) - that allows any third parties (including one sued for infringement) to request patent reexamination, to be part of the reexamination process and to submit evidence of patent invalidity.⁶ Following the American Inventors Act, The IPX system was then replaced by the inter partes review (IPR) proceeding.

Inter partes patent reexamination and review have significant benefits over challenges through litigation. First, petitioners must show invalidity by a “preponderance of the evidence”, while, in court, patents are presumed valid and the challenger must prove invalidity with “clear and convincing evidence”.⁷ This means that there is a lower burden of proof to invalidate a patent in reexamination or review than in court. Second, reexamination and review costs are estimated to be substantially lower than litigation costs.⁸ Finally, courts can, and often do, issue stays of litigation for pending patent suits, allowing the costly civil trial to be put on hold while the PTO adjudicates a reexamination or review (Vishnubhakat et al., 2016).

⁵ See <http://fishpostgrant.com/ex-parte-reexamination/>.

⁶ See <http://www.uspto.gov/web/offices/pac/mpep/s2601.html>

⁷ See

https://www.wilmerhale.com/uploadedFiles/WilmerHale_Shared_Content/WilmerHale_Files/Events/WilmerHale-webinar-IPR1-20Jun13.pdf

⁸ Southard and Prestia (2012) estimate costs of the various procedures, using data from the 2011 AIPLA Economic Survey. They find that the average costs to a final appealable decision are \$128,000 for IPX, while median civil litigation costs are nearly \$2.5 million dollars (for a patent controversy worth between \$1-\$25 million dollars) or \$650,000 (for a controversy worth less than \$1 million). A recent survey by RPX Corp places the average cost of IPR at \$487,000 per petition, positioning it between IPX and civil litigation. See <https://www.rpxcorp.com/2015/07/02/iprs-reality-amid-the-pyrotechnics/>

The early reexamination process, IPX, was initially slow to be utilized. According to published USPTO statistics, only 26 inter partes reexaminations were filed in its first four years.⁹ The next four years saw a still low 282 filings. However, filings appeared to be on an upward climb before IPX was discontinued in 2012 and was replaced with a new reexamination procedure. There were 1,081 IPX filings between 2008 and 2011, and 530 in 2012 alone.

USPTO patent challenges have grown in importance in light of the 2011 America Invents Act, which made several changes to the procedure for third-party reexaminations. First, the AIA changed the standard for granting a request for reexamination, raising the bar from a “substantial new question of patentability” to “a reasonable likelihood that the requester will prevail with respect to at least one claim,” which is expected to increase the rate of reexamination denials (Phillips and Laurence, 2011). This standard took effect for the final year of IPX and remains in effect for IPR. Furthermore, effective September 16, 2012, the Act replaced IPX with Inter Partes Review (IPR) and Post-Grant Review (available for only the first 9 months of a patent's life).¹⁰

The structure of reexamination has changed as well; it now appears closer to litigation and farther from original patent prosecution. Unlike IPX, IPR allows for the deposition of witnesses and other associated discovery, as well as an oral hearing with PTO officials. Stahl and Heckenberg (2011) explain that the “new review proceedings may also be more enticing to a patent challenger since they make available to the accused infringer more procedures analogous to those available in patent litigation.” Most notably, the AIA has mandated that IPR proceed expediently, with an

⁹ See <http://uspto.gov/learning-and-resources/statistics>

¹⁰ Post-Grant Review, however, only applies to patents filed after 03/16/2013 (77 FR 48729). Patents filed earlier than this date are eligible for IPR immediately upon grant. The vast majority of outstanding patents, and all but 3 of the patents in the dataset described in the following section, are eligible for immediate IPR and not post grant review.

expected overall timing of 18 months, half the time expected of IPX.¹¹ Additionally, in IPX only patents filed after November 29, 1999 could be reexamined while in IPR this restriction was lifted, expanding the set of patents that can be challenged.

However, not all changes are beneficial to the requestor. Challenges under the AIA have become substantially more expensive.¹² Furthermore, estoppel, which limits the accused infringer's ability to challenge in litigation the validity of the reexamined claims she earlier challenged in reexamination, has become more restrictive under IPR. Estoppel now binds earlier (before appeals), restricts both district court and future PTO actions, and applies not only to validity grounds that were actually raised in IPR, but to any that could have been raised.¹³ Nevertheless, these changes combined still appear to render IPR more appealing or feasible as a reexamination tool for accused infringers and other third parties. IPR surpassed 3,000 requests in its first three years – over 1,000 more than IPX in its entire 13-year tenure.¹⁴

The policy change has already proven to be controversial. As we mentioned above, multiple concerns have been raised concerns that the PTAB is biased against patentees. Senator Chris Coons co-sponsored a bill that would make it harder to invalidate a patent at the PTO, arguing that the PTO tribunal has become far more powerful than Congress had originally

¹¹ IPR is given statutory time restrictions: 6 months to reach an institution decision (grant or deny), split into a 3-month period for patent owner response (37 C.F.R. § 42.107) followed by another 3-month period for USPTO decision (35 U.S. Code § 314). Then another 12 months to reach a final determination (cancel, confirm, etc.) (35 U.S. Code § 316). Limited 6-month extensions can be granted “for good cause shown”. Thus, we would expect most IPRs to reach a final decision within 18 months, or 1.5 years. By contrast, the median time from filing to certificate issue is 32.7 months for IPX (http://www.uspto.gov/sites/default/files/documents/inter_parte_historical_stats_roll_up_EOY2014.pdf).

¹² This and other statistics on AIA changes from “IPX vs. IPR: A Cheat Sheet,” via Sterne, Kessler, Goldstein.

¹³ For a description of these estoppel changes, see article by Fish and Richardson LLP, available at <http://fishpostgrant.com/post-grant-review/>. Notably, recent court decisions have held that this estoppel does not bind to IPR denials. We discuss the implications of our results for that change in the Section 8.

¹⁴ AIA trial statistics through 9/2015 <http://www.uspto.gov/patents-application-process/appealing-patent-decisions/statistics/aia-trial-statistics>

envisioned.¹⁵ Another concern is the potential for abuse of this new proceeding. According to Walker and Copeland's April 2015 Wall Street Journal article, Kyle Bass, a hedge fund manager, used inter partes review to challenge patents held by pharmaceutical firms solely to profit from short selling their stock or by buying their competitors'.

4. Data

Our data consists of inter partes reexamination and inter partes review filings from 10/10/2010 to 8/24/2014 and their corresponding patents.¹⁶ The midpoint of our window is 9/16/2012, the date that the AIA policy change from IPX to IPR took effect. We next chose a window around this midpoint to ensure we were not truncating IPR outcomes. IPR petitions must be granted or denied (or partially so) within six months of the filing. A trial to decision should be reached within another year. We therefore chose the end date of our sample to be 1.5 years earlier than the last date on which we collected outcomes (2/24/2016); this ensures that each IPR filing in our data had at least 1.5 years from the time it was filed to reach a decision.¹⁷ Next, we took a window of equal duration right before the policy change, which determined our start date, 10/10/2010, allowing for 707 days on either side of the IPX/IPR policy change (9/16/2012).¹⁸ We

¹⁵ Senator Coons' comments are summarized in a January 6, 2016 Duke Law News article. See <https://law.duke.edu/news/patent-pending/>

¹⁶ We concentrate only on utility patents for this analysis. We exclude design patents because they are plausibly systematically different in many respects from utility patents and because, as a practical matter, these patents are often missing in the datasets we use for our analysis. In total, we drop 11 design patents that would otherwise be within our window and have available outcomes.

¹⁷ Note that this does not mean that all observations in the sample have outcomes. Many IPRs will be dropped or settled before ever reaching an outcome. However, this 1.5-year period at the end of the sample ensures that each challenge has had sufficient time for it to have reached an outcome under the provisions of the law.

¹⁸ Because IPX took on average longer than IPR, it is possible that some of the later IPX observations in our sample were still pending when we extracted the reexamination certificates (in March 2016). However, since IPX terminated in 2012, each IPX in our dataset had at least 42 months to reach a decision. According to USPTO published statistics, a "Notice to Issue Reexamination Certificate" is available within 42 months for over 75% of IPX filings without appeals, and for nearly 50% of those with a PTAB appeal decision. See http://www.uspto.gov/about/advisory/ppac/20131121_PPAC_CRU.pdf.

have a total of 1,013 IPX and 1,412 IPR observations, of which 610 and 931, respectively, have outcomes. Figure 1 illustrates a timeline of important dates and the window of time we use for comparing the two systems.

Each observation in our data represents a single (IPX or IPR) “challenge” which we define as a single patent challenged by one party who filed a petition on a certain date. In the IPX system, each challenge corresponds to one reexamination filing. In the IPR system, there could be multiple filings associated with one patent-party-date combination. For example, a party could split its challenge to two filings to overcome a new page limit. We collapse these to a single challenge.

To construct our dataset we combined data on IPX reexaminations, IPR reviews, and the corresponding challenged patents from a number of sources, including several public databases put out by the USPTO: the Patent Examination Research Dataset (PatEx),¹⁹ the PatentsView database,²⁰ the Patent Claims Research Dataset,²¹ and the Patent Assignment Dataset.²² We also use data from DocketNavigator,²³ and the Reed Tech database.²⁴

IPX filings are identified via the PatEx database, which gives us the filing date of each IPX and its associated patent.²⁵ We gather data on the outcome of each reexamination using reexamination certificates (issued under 37 CFR 1.997) which are part of each IPX image file in the Reed Tech database. For file wrappers that were not yet available in the Reed Tech database,

¹⁹ PatEx is a comprehensive database with a range of bibliographic data on public patents. Public patents are those released in Public PAIR, a subset of the private PALM. This is a dataset of over nine million patents, through December 2014. See Graham, Marco, and Miller (2015).

²⁰ This database provides observations for every time one patent cites another. See <http://www.patentsview.org>.

²¹ See Marco, Sarnoff, and deGrazia (October 2016).

²² See Marco, Alan C., Graham, Stuart J.H., Myers, Amanda F., D'Agostino, Paul A and Apple, Kirsten, The USPTO Patent Assignment Dataset: Descriptions and Analysis (July 27, 2015).

²³ The Docketnavigator database provides data on IPR filings, institution decisions, and outcomes since the inception of IPR, as well as litigation filings through 2000. See <http://home.docketnavigator.com/>

²⁴ Reed Tech has a contract with the PTO to crawl their Public PAIR site and archive patent image file wrappers for public download, available at patents.reedtech.com.

²⁵ Coded as children in the “Continuity Data” dataset, with the prefix “95”

we downloaded the reexamination certificates that were available as of August 3, 2016 (the date we last looked for certificates) directly from the Public PAIR website. We then hand coded outcomes of the reexamination process using these certificates. Before a reexamination proceeding, the reexamination request must first be granted or denied by the USPTO. To record denials, we found instances where the image file wrapper contained a document entitled ‘Determination – Reexam denied’ and the reexamination had ceased to go forward; we coded these as a complete denial of reexamination.

We obtained Data on IPRs from DocketNavigator in a similar method to that used by Vishnubhakat et al. (2016). We found patent review filings (by restricting to PTAB cases), and information on whether an IPR was granted, denied, or partially granted.²⁶ A Docket Navigator representative provided additional data with details on the determination of validity of each claim. To merge the different data sources, we used the combination patent-party-date.

[Insert Figure 1 (timeline)]

We have outcomes for 60% of our IPX observations and 66% of our IPR observations. Outcomes may be missing for several reasons. The process may have been terminated before final outcome for some reason, or it may still be ongoing as of the date of our data download. We’ve made an effort to minimize occurrences of ongoing cases by allowing for a 3-year gap between the end of IPX and the data download, and accounting for the statutory restriction on IPR to reach a decision within 1.5 years. IPX reexamination certificates are only issued after appeals are finished, so some of the IPX observations may still be caught up in the federal circuit. Additionally,

²⁶ Denials occur at the claims level. Some claims are denied, while others are granted, reexamination. To account for this difference, we coded a complete denial when there were denials present for an IPR, with no grants or other institution outcomes (joinders, consolidations, etc.) present for that IPR. In this way, a complete denial represents the same thing for IPR as for IPX: a total denial of reexamination and a win for the patentee. These denials may be a relatively weaker win compared to claims confirmations due to estoppel, as we describe in Section 8.

IPR may terminate after the parties settle. We discuss the effects these differences might have on the interpretation of our findings in Section 8.

Each challenged claim may take on one of many outcomes. Claims in IPX may be cancelled (or, very rarely, voluntarily ‘disclaimed’ by the patent holder), confirmed, or amended, and new claims may be added. Compared to IPX, IPR limits the ability to amend or add claims, and is therefore more likely to result in claims that are either cancelled or confirmed. Figure 2 illustrates the frequency of cases that include each outcome in IPX and IPR.

[Insert Figure 2]

We create two new variables by aggregating claim outcomes to the challenge level. The first outcome variable, “Patentee win,” takes the value 1 if the challenge results only in claim confirmations or the addition of new claims, or if reexamination/review was denied; 0 if the outcome was any cancelled, indefinite, disclaimed, or amended claims; and missing if we have no outcome data for the challenge. Because a total denial precludes any claim cancellation, we code Patentee win=1 in the case of a total denial of the reexamination or review request.²⁷ The AIA changed the standard for denials beginning in September 2011, a year earlier than the IPX to IPR transition. In our dataset, denials made up 8% of all outcomes pre-AIA, 13% of all outcomes in the intermediate period between the AIA and IPR, and 27% of outcomes in our sample of IPR. For certain parts of our analysis, we also examine a variant of this outcome variable, called “Patentee win excluding denials,” which is constructed identically, except that cases with total denials are left as missing values.

²⁷ Except for a small share of patents that only have amended claims (2%), all the cases that are classified as patentee win equal 0 are such that at least one of their claims was canceled. We believe amendments likely reduce the scope of the claim which is why we did not count them as a win. However, reversing this classification does not qualitatively change our results.

Not all patent claims are of equal importance to the patentee. The first claim in a patent is likely to be one of particular importance, and breath.²⁸ We, thus, define an outcome variable “claim 1 cancelled” that takes the value 1 if the first claim was canceled and 0 if the challenge is denied or results in a different outcome. We consider this outcome to indicate a significant loss for the patentee.

Figure 3 illustrates the mean values of the outcome variables in IPX and IPR. In IPR, a larger share of challenges end in a patentee win, and claim 1 is invalidated in a smaller share of cases.

[Insert Figure 3]

To obtain data on each challenged patent, we use the variety of USPTO datasets introduced earlier. The PatEx database provides basic information such as filing date, patent grant date, and patent class. The Patent Claims Research Dataset provides the number of independent patent claims at grant, as well as the minimum number of words in these independent claims. We follow Marco, Sarnoff, and deGrazia (2016) and use these two variables as measures of patent scope. Patents with more independent claims, or a fewer minimum number of words in these claims, are expected to be of greater scope. In addition, we sum the number of independent and dependent claims in order to generate claim-normalized variants of certain variables.

The USPTO PatentsView database allows us to find the number of backward and forward citations. These variables are commonly used as proxies for patent value (see for example Lanjouw and Schankerman, 2001, and Harhoff et al., 2003). We collapse the number of times that a patent is cited by other patents to generate the forward citations variable. We similarly collapse the number of patents that are cited by a particular patent to generate the backward citations variable.

²⁸ See for example <http://www.ipwatchdog.com/2014/07/12/understanding-patent-claims/id=50349/>.

Using the existing PatEx data, we also calculate a variable “Age” as the time between patent issue date and the challenge filing date.²⁹ We similarly calculate “Prosecution” as the time between patent filing date and patent issue date. Following Lanjow and Shankerman (2001), we generate per-claim variants for forward and backward citations, as well as for prosecution. We collected forward citations that accrued as of a particular date (12/26/2017). This creates a truncation issue with forward citations since older patents have had more time to accrue citations. To alleviate this problem, we normalize the number of citations by the number of years between the patent’s issue date and the date we collected forward citations.³⁰ The combination of these two transformations results in the new forward citations variable “Annual citations per claim”.

We also classify patents according to their technology area in two distinct ways. First, we record each patent’s USPC classification (included in the PatEx database); our data spans 308 unique USPC classes. Second, we classify each patent according to the six broader NBER patent categories as described in Hall et al. (2001).³¹

5. Preliminary Observations

5.1 The Frequency of Patent Challenges

Figure 4 provides an illustration of the frequency of USPTO challenges over time in our sample window. The figures show a gradual increase in reexamination challenges during the IPX years. Interestingly, there is a spike in IPX reexamination challenges in the last month of IPX in

²⁹ The reexamination filing date was listed as earlier than the patent grant date in 5 observations, causing the age variable to be negative. We treat these as missing values.

³⁰ There seems to be no perfect way to correct for truncation. See Hall et al. (2001) for the limitations of different methods, including the “fixed window” approach. Our data only includes total citations on a specific date, which is why we correct for truncation by finding the annual average. If citations increase at an increasing rate, we might be somewhat underestimating annual citations for younger patents.

³¹ Because the USPTO changes and adds patent classes over time, the original 2001 mapping from USPC class to NBER tech category yields several dozen observations with an unmatchable class in our dataset. To mitigate this problem, we use an updated version of the mapping provided by the NBER Patent Data Project, available online at <https://sites.google.com/site/patentdataproject/Home/downloads/patn-data-description>

anticipation of its displacement by IPR. One explanation for this rush to apply before the change was implemented could be that the petitioners wanted to take advantage of the lower cost of IPX.³² The rate of challenges was lower in the initial few months following the policy change during the last quarter of 2012, which can be explained by the spike that occurred in the last month of IPX. For the remaining IPR period, we observe significantly increased challenge rates.

[Insert Figure 4]

5.2 Mean Characteristics of Patents Reexamined in IPX and IPR

In Table 1, we compare the means of patent characteristics for patents reexamined in IPX with those of patents reviewed in IPR. We restrict to cases for which we observe outcomes. In total, we have 1,541 observations of which 610 are IPX observations and 931 (about 60%) are IPR observations. The mean number of claims is about 27 in IPX and about 31 in IPR, a significant difference. However, there is no significant difference in the number of independent claims; a greater number of dependent claims in IPR than IPX drives this result. In addition, there is no significant difference in the minimum number of words in independent claims; we find no evidence of any difference in patent scope between IPX and IPR. There is also no significant difference in the number of annual forward citations per claim between patents in IPR and patents in IPX (0.27 in IPX and 0.31 in IPR), nor a significant difference in backward citations per claim (3.14 in IPX and 3.15 in IPR). The difference in prosecution time per claim is not significant either (78 days in IPX and 71 days in IPR). The share of patents assigned to small entities is slightly more than 30% in both IPR and IPX.

[Insert Table 1 – compare means IPX and IPR]

³² See for example Baughman (2012) and Sterne, Kessler, Goldstein & Fox P.L.L.C. (2012).

Comparing the frequency of the 6 technology categories in the two systems, there are no differences between the systems for three of the groups; there are significantly more patents in the Computers & Communications category under IPR than under IPX, yet significantly less patents in the Drugs & Medical category and significantly less in the sixth category titled “Others”.

There is a significant difference in the age of challenged patents in the two systems. In IPX the average age is close to 1,314 days (about 3.5 years) and in IPR it is close to 2,354 days (about 6.5 years). It is not surprising that older patents are reexamined in IPR because in IPX only patents filed after November 29, 1999 could be reexamined while in IPR there is no such restrictions.³³ Average age is still higher in IPR if we only remove patents filed before 1999, but if we remove patents filed before November 5, 2001 (707 days, after the November 29, 1999, to mimic the 1999 policy for the IPR period), the difference in age is small and not statistically significant

We also compare the outcome of patent challenges. As shown in Table 1, excluding denials, there is no difference between the share of cases that ended in a win for the patentee (all claimed confirmed). However, accounting for denials, which we believe should also be considered as a win for the patentee, the changes in procedures from IPX to IPR resulted in a significantly higher share of cases that ended with a win for the patentee: in IPR, 36% of the reviewed cases with outcomes were denied review or had all challenged claims confirmed, compared with only 22% of challenged claims in IPX. Our summary statistics also indicate a greater loss for the patentee in the earlier (IPX) system with 58% of IPX reexaminations ending in the first claim canceled compared to 47% in IPR.

³³ The AIA policy reform has also introduced a post grant review for challenging patents filed after March 2013 in the first nine months after they were issued. However, as of April 2016, there are only 3 post grant reviews, and these being excluded from IPR would not explain the difference in average age. See http://www.kilpatricktownsend.com/en/Knowledge_Center/Alerts_and_Podcasts/Legal_Alerts/2013/01/Inter-Partes_Review_Dead_Zone_Eliminated_All_Issued_Patents_Are_Now_Eligible.aspx

5.3. Small Entities

In our analysis below, we distinguish between challenged patents that were issued to an applicant claiming small-entity status and other reexamined patents. In Table 2, we display the mean characteristics of the two groups, small entities and others. The number of claims in the challenged-patents group that were awarded to small entities is not statistically different than the number of claims for other challenged patents. The same is true for both independent claims and the minimum words in independent claims, our measures of patent scope. The patents also do not differ significantly in the number of forward citations per year per claim. However, patents awarded to small entities have significantly fewer backward citations per claim. One possible explanation for this could be less diligence in the search for prior art at the time of patent application. A larger share of patents awarded to small entities come from the Chemical Technology category. The shares of patents from other categories are not significantly different.

[Insert Table 2 – small entities]

6. Preliminary Results

We use different estimation methods to provide evidence on the effect of the AIA policy change on the outcomes of USPTO patent challenges, and on the relationship between these outcomes and the characteristics of the challenged patents. In this section, we first estimate the effect of introducing the new IPR procedure on the probability of a patentee win using nearest neighbor matching. We then present results of discrete choice models estimating the effects of various patent characteristics on the odds of patentee win.

6.1. Comparing IPX and IPR Outcomes using Nearest Neighbor Matching

Using nearest-neighbor matching, we compare patents that are in the same technology category and have similar observed characteristics: patent filing year, number of independent claims, minimum word count in independent claims, per-claim prosecution time, per-claim backward and forward citations (normalized by age), and small-entity status.³⁴ We restrict the matches to one match in the same technology category that is most similar, and replacement is allowed. The results of this comparison are described in Table 3.

[Insert Table 3 nearest neighbor]

This analysis suggests that the share of cases with a patentee win outcome is larger by 15 percentage points in IPR compared to IPX. As we argued earlier, denials of reexamination or review should be viewed as failure to successfully challenge the patent, and thus a win for the patentee. If one neglects to account for denials, the difference in patentee wins would seem small and insignificant.³⁵ Similarly, the share of cases in which the patent's first claim was cancelled is 10 percentage points smaller in IPR than in IPX when accounting for denials.

6.2. Challenge Outcomes and Patent Characteristics

In this section, we use a logit model to examine the relation between patent characteristics and the outcome of the challenge. The main specification of the model that we estimate is given by:

³⁴ We use a bias adjustment to correct for the bias that exists when matching on more than one continuous covariate (claims, prosecution, forward and backward citations) as suggested by Abadie and Imbens (2006, 2011) and implemented by the STATA `teffects` command.

$$Prob(patentee\ win = 1|X, IPR) = \frac{\exp(\alpha + \beta \cdot X + \gamma IPR)}{1 + \exp(\alpha + \beta \cdot X + \gamma IPR)},$$

where X represents a vector of patent characteristics and IPR takes the value 1 for patents reviewed in the post-AIA IPR system and 0 if it was reexamined in the earlier IPX system; alternatively we replace the IPR dummy with a set of quarterly time dummies δt .

In Table 4, column (1) we include independent claims, minimum word count in independent claims, forward- and backward citations, prosecution, small-entity status, and the technology categories. We also include fixed effects for the year that the patent was filed, in order to control for the possibility that patent quality varies over time.³⁶ We find that challenged patents that have a greater minimum number of words in their independent claims are more likely to have a patentee win outcome. In other words, patents of narrower scope are more likely to remain intact after a validity challenge.

[Insert Table 4 – outcome regression]

Patents in the Drugs & Medical technology category are associated with higher odds of patentee win. The drug industry is often considered an industry in which the patent system works particularly well. It is interesting to see that “bad” patents seem to be less prevalent in this industry, at least among those patents which are challenged at the patent office.

Small entity status has a large negative and statistically significant effect on the odds of a patentee win. This could indicate that challenged patents with small-entity status are of lower quality (perhaps because they were less able to afford good patent attorneys or to conduct thorough prior art searches when preparing their patent applications) and are thus more likely to have invalidated claims. Alternatively, this result could be independent of the true quality of small entity

³⁶ These fixed effects are suppressed from our tables. Three filing years are dropped in the logit model because they each only have one observation, and thus perfectly predict success. Twenty-one fixed effects remain, spanning filing years 1993-2013. We arbitrarily choose 2000 as our reference year.

patents, and instead driven by small entities having a weakened position in agency adjudication. Earlier studies (see, for example, Lanjouw and Lerner, 1997) argued that small entities are less likely to assert their patents and are perhaps forced to settle early due to high litigation costs. Small entity patentees could be less able to afford strong legal representation when their patent is challenged and, as a result of weaker legal counsel, they are more likely to have some claims canceled.

In column (2), we add the IPR dummy to the model. The coefficient is positive and significant, consistent with our finding in Section 6.1 that patentees are more likely to win in inter partes review than they were in inter partes reexamination. In column (3), we include, in addition to the IPR indicator, a dummy variable, *Denial Policy Change*, that takes the value 1 in the intermediate period between the passing of the AIA and the beginning of the IPR system, and takes 0 otherwise. Patents challenged during this period were reexamined under the IPX system, but were subject to the initial policy change, which is expected to make denials of reexamination requests more prevalent.

The coefficients of IPR and of Denial Policy Change are both positive and significant. The coefficient of IPR is larger in magnitude than that of Denial Policy Change, and a chi-squared test rejects the equality of these coefficients ($p < .01$). This suggests that the change in the standard for denials had an effect on patentee success, and further that the switch from IPX to IPR had a positive effect on patentee success beyond the effect of the changed denial policy.³⁷ The coefficients of other variables of interest remain similar to those reported in column (1). The coefficient of the drugs & medical product category remains significant.

³⁷ It is possible that IPR judges interpret the denial policy differently than IPX examiners, explaining the smaller increase in denials in the first year, when IPX was still in effect.

In column (4), we reproduced the model from column (2) along with time dummies for each challenge filing quarter. We suppressed the coefficients of all time dummies in column (4). The omitted categories are the first quarter of IPX in our sample, which is the fourth quarter of 2010, and the last period of IPR, which is the third quarter of 2014.³⁸ Our results using time dummies remain qualitatively the same as those in column (2): the effects of minimum independent claim word count, small entity status, drugs & medical patents, and the IPR policy change maintain their sign and statistical significance.

[Insert Table 5]

In Table 5 we present results from the same models as in Table 4, except we replace the dependent variable with the first claim canceled outcome which represents a significant loss to the patentee. Again we find evidence consistent with patentees faring better in challenges in the IPR system. Both our denial policy indicator and our IPR policy indicator are associated with lower odds of having a patent's first claim cancelled. Small entities are more likely to suffer a significant loss in patent rights. In addition, patents with greater per-claim prosecution times are less likely to have their first claim cancelled. This could indicate that patents that were more diligently examined are less likely to suffer a significant loss. Patents with more independent claims are less likely to have the first claim invalidated, but using the minimum word count measure, broader scope patents do not appear to have a different probability of first claim cancelation.

³⁸ If we only include time effects, the time effects before the policy change were not significantly different than for the first quarter in our data. Time effects are positive yet remain statistically insignificant for the first four quarters after the policy change. Starting in the last quarter of 2013, these effects become larger in magnitude and statistically significant.

7. Accounting for Selection

In this section, we deal with two issues that might have biased our estimate of the IPR effect. First, patent challengers might have selected between the IPX and IPR systems in a way that biases the effect of the policy change on examination outcomes. Second, we consider sample selection – the quality of patents selected into the set of administratively challenged patents with observed outcomes might have changed with the AIA.

7.1. Selection between IPX and IPR

By timing their requests, some petitioners could have selected between the IPX and the IPR systems. Indeed, figure 2b clearly shows a spike in IPX reexaminations right before the change to IPR. This would cause bias in the IPR coefficient if this selection is associated with differences in patent quality. While we control in tables 4 and 5 for observed characteristics, there might be unobserved patent quality differences that drove selection between the systems. We use an instrumental variable approach to account for the possible endogeneity of the IPR variable.

To construct our instrument, we exploit the fact that not all patents were eligible to be challenged in either system. Our instrument “IPX-ineligible” is defined to equal 1 if a patent was granted after September 16, 2012, when the IPR system took effect and additionally if the patent was filed before September 16, 2011, the date that the AIA became law. The first restriction guarantees that these patents could only be challenged in IPR but not in IPX. The second restriction guarantees that all of our IPX-illegible patents were filed before the AIA became law which eliminates the concern that the AIA could have incentivized filings of patents of a higher quality. The patents we define as IPX-ineligible were already under review when the AIA was signed, therefore, patentees and challengers were unable to perfectly predict whether the patent would

issue in time to be eligible for IPX, or only for IPR. Six percent of the patents in our sample satisfy these criteria.

We perform a balancing test by regressing IPX-ineligible as the dependent variable on observed characteristics. Controlling for patent filing year, only prosecution time is significant and the joint F test is not significant.³⁹ This provides reassurance that our instrument satisfies the exclusion restriction. We see no reason for this instrument to directly affect the quality of the patent or the strength of evidence against it, except through the policy change indicator, IPR. The results of the first stage, which show the strong effect of our instruments on the policy variable are presented in the appendix Table A1. We estimate the two-stage model:

$$IPR = \alpha_2 + \beta_2 \cdot X + \gamma_2 IPX_{\text{ineligible}} + \varepsilon$$

$$Patentee\ Win = \alpha_3 + \beta_3 \cdot X + \omega \widehat{IPR} + u$$

Table 6 presents the results of the second stage of a two-stage least squares model. In column (1) we estimate the model with patentee win as our dependent variable, and in column (2) we present results for the first claim canceled dependent variable. Qualitatively, the effects of observed patent characteristics are similar to those we found in the previous subsection. In particular, we find that patents of broader scope are less likely to win a validity challenge, but also less likely to suffer the significant loss of having their first claim cancelled. Patents issued to small entities are less likely to win a validity challenge, and more likely to have their first claim cancelled. When using the instruments to account for selection on unobservables, the effect of the

³⁹ For an explanation of this test see <http://blogs.worldbank.org/impactevaluations/tools-trade-joint-test-orthogonality-when-testing-balance>.

IPR policy variable retains its sign and statistical significance in the patentee win specification, and narrowly misses significance ($p=.053$) in the first claim cancelled specification.⁴⁰

7.2. Selection of administrative challenges

Challenged patents may be different from other litigated patents because use of IPR and IPR is a strategic choice.⁴¹ Selection patterns could have changed with the AIA reform. Heckman (1979) proposed a procedure to test and account for sample selection bias. The first stage of his procedure is to estimate a probit model to predict the likelihood of selection into the regression sample – here the set of patents challenge with observed outcomes. Then, convert the predicted values into inverse mills ratios (IMR), defined as the ratio between the density and the cumulative distribution function and include it in the outcome regression. This procedure can also be used when there is an endogenous explanatory variable by including the instrument for the endogenous variable in the selection model, and including the IMR as an additional instrument in the two stage least squares procedure.⁴²

The selection model is designed to determine, for each observation with a non-missing patentee win outcome, the likelihood that it would have been selected into a post-grant challenge outcome. The sample includes the relevant population of patents, whether selected or not. Because most patent challenges arise from district court litigation, the population we consider –

⁴⁰ In a reduced form discrete choice model in which we use the instruments directly in place of the IPR indicator, the coefficients for the IPR instruments are positive and significant, consistent with the two-stage estimation.

⁴¹ Priest and Klein (1984) argue that litigated disputes are different from those that settle; Bar and Costello (2018) show post grant challenged patents have different characteristics than other litigated patents.

⁴² See Wooldridge, 2002 pages 567-570 and Wooldridge also explains this method in more detail with sample code at <https://www.statalist.org/forums/forum/general-stata-discussion/general/1295287-heckman-sample-selection-and-instrumental-variable-iv-or-simultaneous-equations-model>.

in addition to the challenged patent with outcomes – is other litigated patents that were not challenged at the patent office.

While Heckman’s method does not necessarily preclude uses of the same covariates in the selection and outcome models, this could generate collinearity (Puhani, 2000). To avoid this problem, we include in the selection model a variable that is excluded from the outcome regression: *assigned* -- a dummy variable that takes the value 1 if the patent was assigned.⁴³ Within the pool of litigated patents, we do not expect assignment to be associated with patent quality. Indeed, assignment and patentee win have a low correlation of only .004. Likewise, it is not a statistically significant predictor of outcomes when regressed either by itself or along with our usual covariates. However, assignment is a strong predictor of selection into post-grant challenges.

We first use a probit model to estimate selection:

$$S = 1(\alpha_1 + \beta_1 \cdot X + \gamma_1 IPX_ineligible + \varphi assigned + v > 0)$$

The controls X and the instrument $IPX_ineligible$ are as described in the previous section. We compute and save the inverse mills ratios for each selected observation. We then estimate the 2SLS model including the mills ratio as a control, and using again $IPX_ineligible$ as the instrument for IPR

$$Patentee\ Win = \alpha + \beta \cdot X + \rho IMR + \omega \widehat{IPR} + u$$

As an alternative or addition to the assigned variable, we use age. Marco (2004) suggested one could omit age from the outcome model, but in his study, he could not use this variable in the selection equation because age is current while selection into litigation occurs any

⁴³ For the non-selected observations, it is equal 1 if a patent was assigned before the date it was litigated.

time during the observed patent life. In our application, however, selection refers to the choice whether and how to challenge validity conditional on an observed dispute.

In table 7 we display the results from the patentee win regressions and for claim 1 canceled in columns 1-3 and 4-5 respectively. Columns (1) and (4) corresponds to a selection model using the excluded variable assigned. In columns (2) and (5) we replace the variable assigned with age, and in columns (3) and (6) we use both.

In the patentee win models, there is no evidence of selection, as the inverse mills ratio, which tests for selection bias (Wooldridge, 2002), is insignificant. In the claim 1 cancelled models, there is some evidence of selection. Still, our main results are robust to the sample selection correction, and do not appear to be sensitive to the construction of the selection equation. Specifically, the policy indicator retains its sign and has a similar magnitude to the estimate in table 6, as does the effect of small entity status.

8. Possible drivers of increased patentee wins

The AIA changed conditions for appeals, settlements and denials of applications. In this section, we discuss the possible implications of these changes.

8.1 Can appeals or settlements explain the difference in patentee wins?

As we noted earlier, our dataset records the outcome of inter partes reexaminations at a later stage of the appeals process than inter partes reviews. More specifically, we record IPX outcomes from reexamination certificates, which are only issued after any appeals. By contrast, IPR outcomes are recorded immediately following the PTAB trials, before any appeals. We explain why this difference is highly unlikely to explain the higher rate of patentee win in IPR. Taylor and Kamkar (2017) examine the success rate of appeals of IPR. They find that (in 2016)

the Federal Circuit affirmed 75% of appealed cases, reversed the PTAB decision only in 3% of the appeals and returned the remaining 22% to PTAB, where most were then partially affirmed. A quick back of envelope calculation shows that even if all patentee win cases were appealed and 25% of them were reversed, the rate of patentee win in IPR would decrease from 36% to 27%, which is still significantly different than the rate in IPX (22%).⁴⁴ Accounting for the facts that patentees can also appeal the outcomes of IPR, that there are more cases with at least one claim canceled than ones with patentee win, and that denials of IPR are only rarely reversed, we don't expect the share of patentee wins could drop as much with appeals.

Another difference between IPX and IPR is that settlements are possible during IPR which would result in termination of the review process. The same was not true in the IPX system. This could explain a higher rate of patentee wins if patents of poor quality more likely settle. However, as we have seen in section 7, selection does not seem to be driving the positive effect of IPR on patentee win. One reason why this difference might not have a significant effect is that the parties involved in an IPX challenges, likely faced similar incentives to settle, only before the request for reexamination, knowing they could not settle during IPX. Moreover, denials of review are an important reason for the higher rate of patentee win in IPR, and these decisions are reached early in the process.

8.2. Denials

We treat denials in this study as a win for the patentee, because no claims are canceled if the challenge is denied. Estimating the model from table 7 again only excluding denials we obtain an IPR coefficient that is closer to zero, see Appendix table A2. Thus, denials are the main

⁴⁴ Using a test of proportion equality under this hypothetical scenario, we reject the null hypothesis that the rates of patentee win would be equal ($p=.03$).

driver of the positive effect of IPR on the rate of patentee win. In addition, selection bias is more pronounced when we exclude denials.

The fact that IPR wins come primarily in the form of denials has important policy implications. In 2016, the Federal Circuit suggested that IPR denials should not have estoppel effect.⁴⁵ This means that the alleged infringer can still challenge the patent's validity in court. Therefore, denial wins may have become less valuable to patentees than a claims confirmation. In April 2018, the Supreme Court rejected the patent office's practice of partially instituting IPRs.⁴⁶ Instead, the PTO must either deny a petition in its entirety, or issue a final written decision on each challenged claim. It remains to be seen how this change will affect the rate of reexamination denials.

9. Conclusions

Filings of patent validity challenges at the patent office, while still low relative to litigation, have been increasing, especially since the change to the new IPR procedure. A system that offers an administrative venue to challenge patent validity is expected to improve patent quality and lower the private and social costs of resolving patent disputes. Indeed, our data shows that in more than two-thirds of cases the challenged patent had at least one claim canceled and in more than half of the cases the first patent claim was canceled. Thus, these patent challenges significantly reduce the breadth of challenged patents. This article sheds light on the characteristics of patents challenged at the USPTO, and how these characteristics are associated with the probability that a post-grant challenge results in a win for the patentee (claims confirmed or reexamination denied)

⁴⁵ *Shaw Indus. Grp., Inc. v. Automated Creel Sys., Inc.*, 817 F.3d 1293 (Fed. Cir. 2016)

⁴⁶ *SAS Institute Inc. v. Iancu* (2018).

or a significant loss (claim 1 canceled), and identifies the effects of the AIA policy change on patentee win outcomes.

The AIA resulted in an increase in the frequency of denied patent challenge requests. Accounting for denials, which we take to be a win for the patentee, we find that there are more patentee wins in the new IPR system than in the old IPX system. We exploit the ineligibility of patents granted after the policy change to be challenged in the IPX system to instrument for the policy change indicator and correct for possible bias due to strategic selection between the two systems. We still find evidence that the policy change had a positive effect on patentee wins. This result is also robust when controlling for sample selection.

The drugs and medical category, for which the patent system is often considered to work best, stands out as one in which challenges are most likely to end in a patentee win. But other categories do not have a significant effect on outcomes. The share of patents in the drugs and medical category was in fact smaller since the policy change, which suggests that patent category composition changes is unlikely to have contributed to the increase in patentee wins in IPR.

Small-scale inventors make a significant contribution to innovation. Earlier studies have shown, however, that small patentees are disadvantaged when it comes to patenting and to asserting their patents. We find that small-entity-status patentees are significantly more likely to have at least one claim cancelled when challenged, and also more likely to suffer the significant loss of having their first claim cancelled. We proposed two possible explanations for this result; these patent owners may be disadvantaged in validity disputes due to their limited resources, or they may have obtained weaker patents to start with. More research should be done into the cause of this effect, and the possible role that patent-assertion entities may play with regard to small entity patents.

The USPTO already offers reduced fees for small entities filing a patent application. Our findings suggest that there may be room for additional policy interventions. It is possible that providing small-entity inventors with an earlier subsidy to help them draft patent applications could improve patent quality and strengthen their positions in patent disputes. Similarly, if this effect is driven by weakened positions in patent challenges, the USPTO could consider whether there are ways to reduce the cost burden that inter partes review imposes on small entities.

The high rate of claims cancelation highlights the importance of having low cost procedure for third parties to challenge patent validity. Although patent reexamination filings have increased since the AIA policy change, some of this increase was likely driven by removal of a restriction on reexamination of patents filed before 1999, (which would have faded over time without the AIA), and possibly also by trends in filing litigation cases. The AIA did not make patent reexaminations unambiguously more appealing compared to IPX (for example, reexamination costs have gone up), and we have also found a significant increase in denials and an overall lower success rate for challengers. A sharp increase in IPX filings immediately before the new IPR system took effect also seems to suggest some third parties preferred the IPX system. If policy makers seek to significantly expand the uses of patent challenge procedures, further policy changes (for example cutting costs) may be needed.

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Tables and Figures

Figure 1: Timeline of Samples

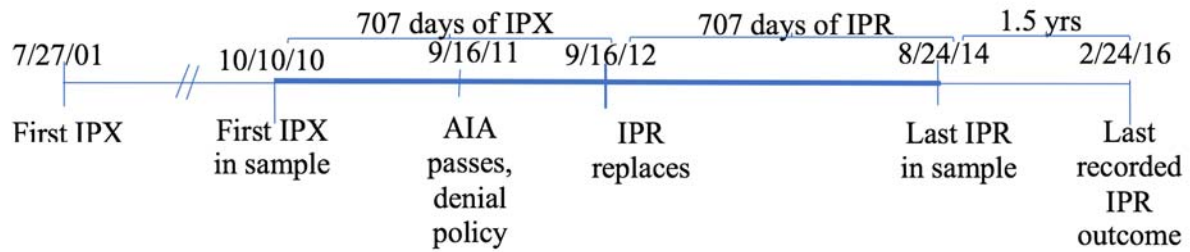


Figure 2: Percentage of Challenges Including Various Claim-level Outcomes

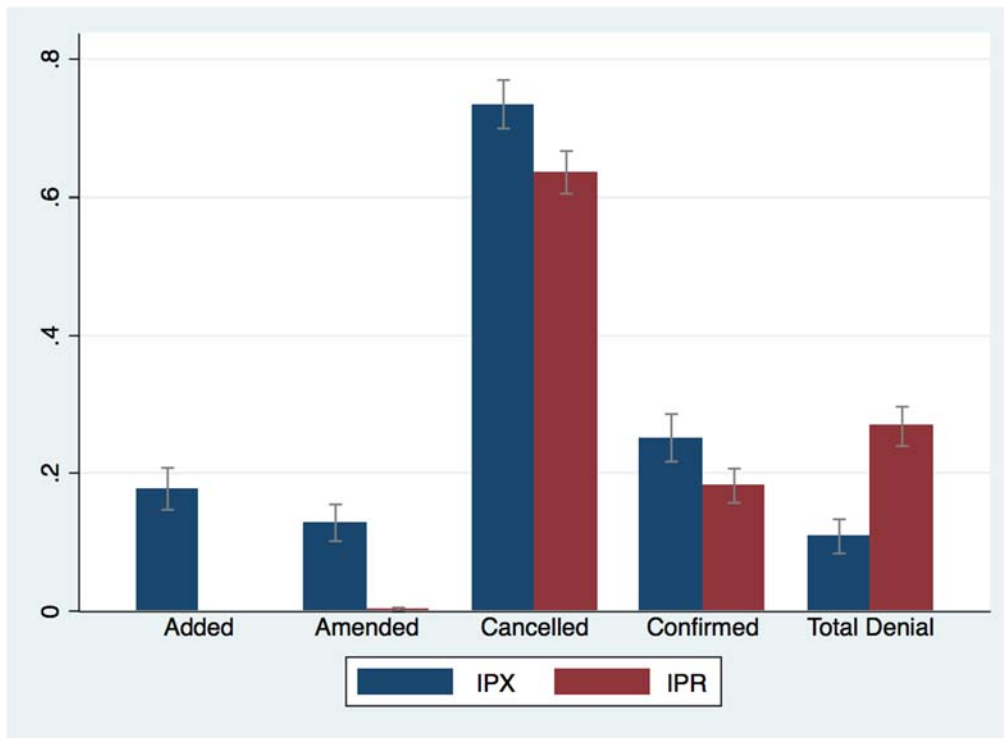


Figure 3: Comparing Challenge Outcomes in IPX and IPR

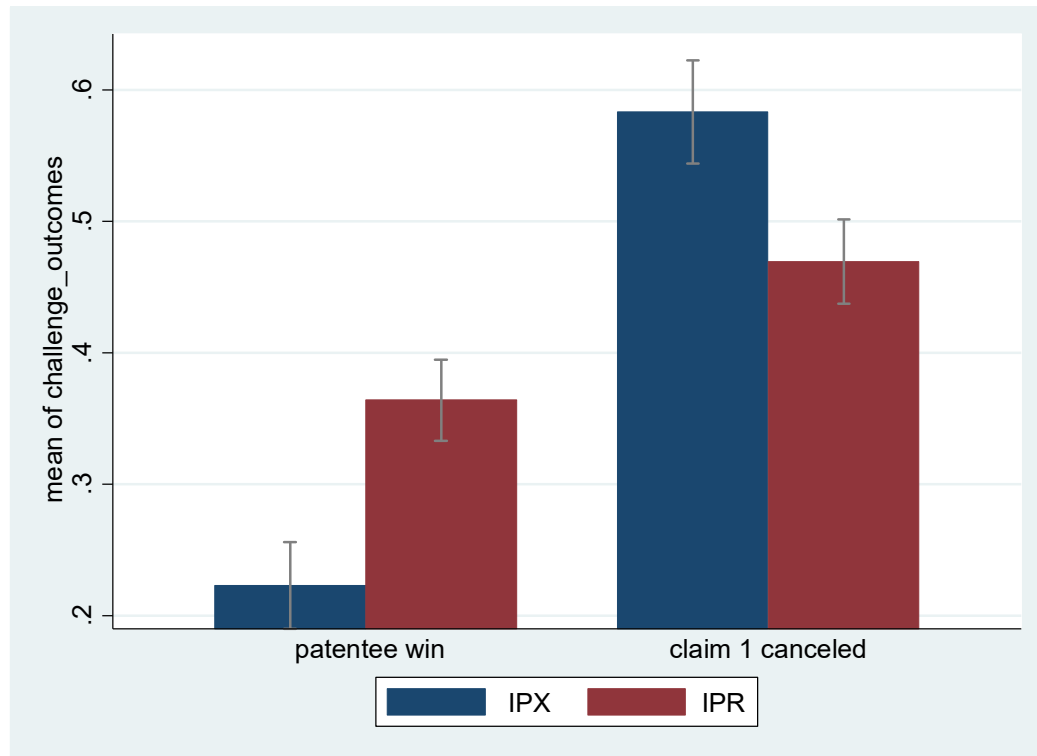
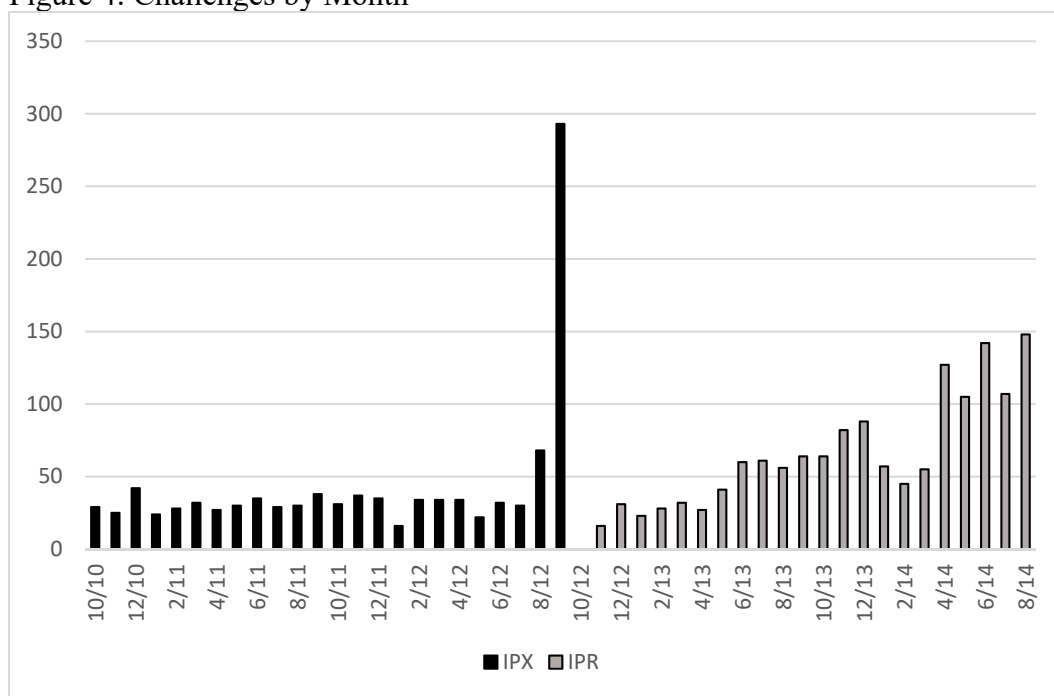


Figure 4: Challenges by Month



Reexamination challenges reported in this figure are at the patent-party-date level. The number is equal to filings in the IPX months, and is lower than the number of filings in the IPR months. The AIA passed in September, 2011, the denials change was implemented immediately, the change from IPX to IPR was implemented on September, 2012.

Table 1- Comparing IPX and IPR characteristics and outcomes

Variable	IPX	IPR	p-value
Independent claims	3.82	4.12	0.11
Min. word length in independent claims	137.44	137.36	0.98
Total claims	27.23	30.80	0.01
Annual forward citations per claim	0.27	0.31	0.38
Backward citations per claim	3.14	3.15	0.97
Prosecution per claim	78.42	71.46	0.32
Small entity	0.32	0.31	0.70
Age	1314.03	2354.50	0.00
N	610	931	
Tech Category 1 (Chemical)	0.06	0.05	0.56
Tech Category 2 (Computers & Communications)	0.40	0.52	0.00
Tech Category 3 (Drugs & Medical)	0.15	0.12	0.04
Tech Category 4 (Electrical & Electronic)	0.14	0.14	0.89
Tech Category 5 (Mechanical)	0.09	0.08	0.59
Tech Category 6 (Others)	0.17	0.09	0.00
N	610	930	
Patentee win excluding denials	0.13	0.13	0.87
First claim cancelled excluding denials	0.65	0.64	0.62
N	544	682	
Patentee win	0.22	0.36	0.00
First claim canceled	0.58	0.47	0.00
Denied	0.11	0.27	0.00
N	610	931	

Sample includes challenge cases between 10/10/2010 and 8/24/2014 with non-missing outcomes. Comparisons of small entity, denied, tech categories, and outcomes reflect two-sample tests of proportion equality. The remainder reflect two-sample t-tests of mean equality. “Patentee win” includes cases in which all reexamined or reviewed claims were confirmed, or for which application was denied. “Patentee win excluding denial” excludes from the sample cases in which reexamination/review was denied. The minimum word length variable is missing one observation.

Table 2- Comparing challenged patents issued to small entities and non-small entities

Variable	Non-small	Small	p-value
Independent claims	4.05	3.90	0.44
Min. word length in independent claims	134.77	143.19	0.07
Total claims	29.75	28.59	0.43
Annual forward citations per claim	0.31	0.26	0.29
Backward citations per claim	3.84	1.62	0.00
Prosecution per claim	73.01	76.87	0.60
Age	1984.09	1850.69	0.14
N	1062	479	
Tech Category 1 (Chemical)	0.04	0.08	0.01
Tech Category 2 (Computers & Communications)	0.48	0.44	0.15
Tech Category 3 (Drugs & Medical)	0.13	0.12	0.57
Tech Category 4 (Electrical & Electronic)	0.13	0.16	0.18
Tech Category 5 (Mechanical)	0.09	0.06	0.06
Tech Category 6 (others)	0.11	0.13	0.25
N	1061	479	

Sample includes patents challenged in IPR or IPX (with non-missing outcomes) between 10/10/2010 and 8/24/2014. This data is at the level of reexamination or review, so some patents appear multiple times. Comparisons of tech categories reflect two-sample tests of proportion equality. The remainder reflect two-sample t-tests of mean equality. The minimum word length variable is missing one observation.

Table 3- IPR “treatment” effect

Effect\Sample	Include denials	Exclude denials
Average treatment effect of IPR on patentee win	0.147***	-0.006
AI Robust Std. Err.	(0.028)	(0.024)
Average treatment effect of IPR on First Claim Canceled	-0.1***	0.004
AI Robust Std. Err.	(0.032)	(0.033)
N	1,540	1,225

Standard error is robust to account for multiple continuous covariates, as suggested by Abadie and Imbens (2006, 2011).

*** significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table 4: Patentee Win

Variable	(1)	(2)	(3)	(4)
Independent Claims	0.002 (0.018)	0.003 (0.019)	0.003 (0.019)	0.002 (0.019)
Min. word count in independent claims	0.002*** (0.001)	0.002*** (0.001)	0.002*** (0.001)	0.002*** (0.001)
Annual Forward citations per claim	-0.128 (0.121)	-0.139 (0.128)	-0.145 (0.127)	-0.165 (0.132)
Backward Citations per claim	0.001 (0.009)	0.0002 (0.009)	0.001 (0.009)	0.003 (0.008)
Prosecution per claim	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001* (0.01)
Small entity	-0.410*** (0.127)	-0.413*** (0.129)	-0.411*** (0.129)	-0.372*** (0.134)
TC 1 (Chemical)	-0.192 (0.340)	-0.266 (0.341)	-0.292 (0.343)	-0.323 (0.349)
TC 2 (Computers & Communications)	0.380* (0.198)	0.250 (0.200)	0.240 (0.201)	0.238 (0.203)
TC 3 (Drugs & Medical)	0.605*** (0.233)	0.546** (0.234)	0.525** (0.234)	0.561** (0.237)
TC 4 (Electrical & Electronic)	0.195 (0.236)	0.086 (0.241)	0.098 (0.241)	0.064 (0.243)
TC 5 (Mechanical)	0.270 (0.263)	0.186 (0.265)	0.166 (0.266)	0.196 (0.271)
IPR		0.682*** (0.131)	0.956*** (0.194)	1.234*** (0.380)
Denial Policy Change			0.418* (0.215)	
Challenge filing quarter effects	No	No	No	Yes
Patent filing year effects	Yes	Yes	Yes	Yes
Constant	-1.055*** (0.299)	-1.324*** (0.305)	-1.602*** (0.340)	-1.398*** (0.445)
pseudo R-sq	0.036	0.051	0.053	0.067

Notes: Sample includes 1536 challenge cases between 10/10/2010 and 8/24/2014. Logit model estimated. Standard errors in parenthesis.

*** significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table 5: First Claim Cancelled

Variable	(1)	(2)	(3)	(4)
Independent Claims	-0.082*** (0.021)	-0.082*** (0.02)	-0.082*** (0.02)	-0.081*** (0.021)
Min. word count in independent claims	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
Annual Forward citations per claim	-0.101 (0.074)	-0.097 (0.075)	-0.090 (0.074)	-0.088 (0.075)
Backward Citations per claim	0.004 (0.009)	0.005 (0.009)	0.004 (0.009)	0.003 (0.009)
Prosecution per claim	-0.001** (0.000)	-0.001** (0.000)	-0.001** (0.000)	-0.001** (0.000)
Small entity	0.329*** (0.115)	0.331*** (0.116)	0.327*** (0.116)	0.288** (0.119)
TC 1 (Chemical)	-0.105 (0.276)	-0.045 (0.279)	-0.024 (0.280)	-0.03 (0.283)
TC 2 (Computers & Communications)	-0.171 (0.174)	-0.081 (0.175)	-0.071 (0.175)	-0.073 (0.177)
TC 3 (Drugs & Medical)	-0.325 (0.213)	-0.286 (0.212)	-0.266 (0.212)	-0.284 (0.214)
TC 4 (Electrical & Electronic)	-0.019 (0.208)	0.054 (0.212)	0.043 (0.212)	0.071 (0.213)
TC 5 (Mechanical)	-0.209 (0.237)	-0.153 (0.239)	-0.135 (0.240)	-0.144 (0.245)
IPR		-0.453*** (0.118)	-0.661*** (0.163)	-0.706** (0.338)
Denial Policy Change			-0.330* (0.179)	
Challenge filing quarter effects	No	No	No	Yes
Patent filing year effects	Yes	Yes	Yes	Yes
Constant	0.440 (0.275)	0.599** (0.279)	0.808*** (0.298)	0.481 (0.381)
pseudo R-sq	0.029	0.036	0.038	0.049

Notes: Sample includes 1536 challenge cases between 10/10/2010 and 8/24/2014. Logit model estimated. Standard errors in parenthesis.

*** significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table 6: Instrumental Variable Approach (Second stage estimates)

Variable	Patentee win (1)	Claim 1 canceled (2)
IPR	0.341*** (0.128)	-0.248* (0.128)
Independent claims	0.001 (0.004)	-0.018*** (0.004)
Min. word count in independent claims	0.0004*** (0.0002)	-0.0003 (0.0002)
Annual Forward citations per claim	-0.026 (0.021)	-0.022 (0.017)
Backward Citations per claim	-0.0004 (0.002)	0.0013 (0.002)
Prosecution per claim (*100)	0.0002 (0.000)	-0.0002*** (0.000)
Small entity	-0.081*** (0.025)	0.078*** (0.028)
TC 1 (Chemical)	-0.073 (0.059)	0.009 (0.069)
TC 2 (Computers & Communications)	0.00314 (0.046)	0.009 (0.049)
TC 3 (Drugs & Medical)	0.09* (0.048)	-0.055 (0.051)
TC 4 (Electrical & Electronic)	-0.019 (0.05)	0.036 (0.055)
TC 5 (Mechanical)	0.007 (0.055)	-0.018 (0.06)

Constant	0.144*	0.683***
	(0.076)	(0.079)
Patent filing year effects	Yes	Yes
R-sq	0.024	0.035

Notes: Sample includes 1539 challenge cases between 10/10/2010 and 8/24/2014. Standard errors in parenthesis.

*** significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table 7: Patentee win: Controlling for Sample Selection and endogeneity

Dependent variable	Patentee win			Claim 1 Canceled		
Excluded variable added to selection	Assigned	Age	Assigned and Age	Assigned	Age	Assigned and Age
	(1)	(2)	(3)	(4)	(5)	(6)
IPR	0.355*** (0.133)	0.327*** (0.117)	0.341*** (0.123)	-0.274** (0.133)	-0.245** (0.117)	-0.263** (0.124)
IMR	-0.207 (0.144)	0.738 (0.640)	0.002 (0.137)	0.386** (0.153)	-0.165 (0.643)	0.246* (0.140)
Independent claims	0.001 (0.004)	0.000 (0.004)	0.001 (0.004)	-0.019*** (0.004)	-0.018*** (0.004)	-0.019*** (0.004)
Min. word count in independent claims	0.0003* (0.000)	0.0009** (0.000)	0.0004** (0.000)	-0.0000 (0.000)	-0.0003 (0.000)	-0.0001 (0.000)
Annual Forward citations per claim	-0.044* (0.024)	0.039 (0.059)	-0.026 (0.024)	0.012 (0.022)	-0.036 (0.058)	0.000 (0.021)
Backward Citations per claim	-0.001 (0.002)	-0.001 (0.002)	0.000 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)
Prosecution per claim (*100)	0.0002* (0.000)	0.0000 (0.000)	0.0002 (0.000)	-0.0003*** (0.000)	-0.0002 (0.000)	-0.0003*** (0.000)
Small entity	-0.08*** (0.025)	-0.097*** (0.029)	-0.081*** (0.025)	0.075*** (0.028)	0.081*** (0.031)	0.073*** (0.028)
TC 1 (Chemical)	-0.109 (0.068)	0.047 (0.105)	-0.073 (0.060)	0.075 (0.076)	-0.018 (0.111)	0.052 (0.070)
TC 2 (Computers & Communications)	0.028 (0.045)	-0.094 (0.116)	0.003 (0.053)	-0.037 (0.049)	0.031 (0.117)	-0.018 (0.056)
TC 3 (Drugs & Medical)	0.118**	0.000	0.09*	-0.108**	-0.035	-0.089

	(0 .050)	(0.101)	(0.054)	(0.054)	(0.103)	(0.057)
TC 4 (Electrical & Electronic)	-0.037	0.048	-0.019	0.070	0.021	0.059
	(0.054)	(0.059)	(0.048)	(0.058)	(0.065)	(0.054)
TC 5 (Mechanical)	0.024	-0.071	0.007	-0.050	0.000	-0.036
	(0.054)	(0.098)	(0.057)	(0.060)	(0.101)	(0.062)
Constant	0.562**	-1.368	0.139	-0.098	1.022	0.186
	(0.286)	(1.355)	(0.312)	(0.304)	(1.362)	(0.320)
Patent filing year effects	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.020	0.034	0.024	0.034	0.036	0.034

Notes: Sample includes 1539 challenge cases between 10/10/2010 and 8/24/2014. Estimation using 2SLS. Standard errors in parenthesis.

*** significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table A1: First stage estimates

Variable	IPR
Independent claims	-0.001 (0.004)
Min. word count in independent claims	0.0000 (0.000)
Annual Forward citations per claim	0.014 (0.018)
Backward Citations per claim	0.002 (0.002)
Prosecution per claim (*100)	-0.0001 (0.0000984)
Small entity	-0.00126 (0.0246)
TC 1 (Chemical)	0.127** (0.0588)
TC 2 (Computers & Communications)	0.206*** (0.0363)
TC 3 (Drugs & Medical)	0.0871* (0.0450)
TC 4 (Electrical & Electronic)	0.171*** (0.0447)
TC 5 (Mechanical)	0.130** (0.0516)
IPX-ineligible	0.453*** (0.0292)
Patent filing year effects	Yes
Constant	0.347*** (0.062)
R-sq	0.205

Notes: The sample includes 1539 challenge cases between 10/10/2010 and 8/24/2014. IPX-ineligible is the instruments omitted in the second stage. Standard errors in parentheses. * p<.10 ** p<.05 *** p<.01

Table A2: Selection model for table 7

Variable	Assigned (1)	Age (2)	Assigned and Age (3)
Independent claims	-0.001 (0.003)	0.000 (0.003)	0.000 (0.003)
Min. word count in independent claims	0.0006*** (0.000)	0.0007*** (0.000)	0.0006*** (0.000)
Annual Forward citations per claim	0.098*** (0.017)	0.095*** (0.016)	0.091*** (0.016)
Backward Citations per claim	0.000 (0.002)	-0.001 (0.003)	0.000 (0.002)
Prosecution per claim (*100)	-0.0003** (0.000)	0.0001 (0.000)	0.0002 (0.000)
Small entity	-0.025 (0.028)	-0.018 (0.028)	-0.029 (0.028)
TC 1 (Chemical)	0.180*** (0.069)	0.187*** (0.069)	0.180*** (0.070)
TC 2 (Computers & Communications)	-0.113*** (0.043)	-0.156*** (0.042)	-0.0970** (0.043)
TC 3 (Drugs & Medical)	-0.146*** (0.052)	-0.136*** (0.051)	-0.139*** (0.052)
TC 4 (Electrical & Electronic)	0.102** (0.051)	0.0946* (0.051)	0.100* (0.052)
TC 5 (Mechanical)	-0.111* (0.059)	-0.143** (0.059)	-0.118** (0.059)
IPX-ineligible	-0.028 (0.059)	0.013 (0.060)	0.000 (0.060)
Assigned	-0.223*** (0.027)		-0.229*** (0.027)
Age		0.00008*** (0.0002)	0.00009*** (0.0002)
Constant	-1.517*** (0.065)	-1.915*** (0.094)	-1.819*** (0.096)

Notes: Sample includes 33,416 litigated patents or challenged with IPX of IPR between 10/10/2010 and 8/24/2014. The probit model is used for the selection estimation. All models include patent filing year fixed effects. Standard errors in parentheses. * p<.10 ** p<.05 *** p<.01

Table A3: Patentee win excluding denials: Controlling for Sample Selection and endogeneity

Variable	Patentee Win	Claim 1 Canceled
	(1)	(2)
IPR	0.141 (0.119)	-0.153 (0.151)
IMR	-0.249** (0.127)	0.509*** (0.174)
Independent claims	0.141 (0.119)	-0.023*** (0.004)
Min. word count in independent claims	0.004 (0.004)	0.0001 (0.000)
Annual Forward citations per claim	0.0002 (0.000)	-0.012 (0.052)
Backward Citations per claim	-0.052*** (0.017)	0.002 (0.003)
Prosecution per claim (*100)	-0.001 (0.001)	-0.0003** (0.000)
Small entity	0.0002** (0.000)	0.089*** (0.029)
TC 1 (Chemical)	-0.091*** (0.020)	-0.017 (0.118)
TC 2 (Computers & Communications)	-0.040 (0.057)	-0.030 (0.104)
TC 3 (Drugs & Medical)	0.048 (0.035)	-0.081 (0.100)

TC 4 (Electrical & Electronic)	0.129*** (0.042)	0.028 (0.069)
TC 5 (Mechanical)	0.004 (0.046)	-0.055 (0.095)
Constant	0.592** (0.261)	-0.331 (0.361)
Patent filing year effects	Yes	Yes
R-sq	0.015	0.048

Notes: Sample includes 1224 challenge cases between 10/10/2010 and 8/24/2014. We excluded complete denial cases from the data. Estimation using 2SLS. Standard errors in parenthesis. We did not include the model with age as an excluded variable because it is insignificant in the first stage.

*** significant at 1% level, ** significant at 5% level, * significant at 10% level.