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ABSTRACT

Continuations allow inventors to claim technology developed after the original filing date of a patent, leading to concerns about inadvertent infringement and hold-up. For researchers seeking to study this practice, a key challenge is the difficulty of linking patent applications to potentially infringing technology. We use the link created by disclosure of standard essential patents (SEPs) to analyze the relationship between standard publication — a key observable milestone in technology development — and continuation filing. More than half of the SEPs in our data are filed after standard publication. There is a substantial increase in continuation filings immediately after standard publication, and this increase is larger when the initial patent examiner is more lenient. We also find that claims in SEP continuations are more likely to be rejected for double patenting (indicating an effort to change the scope of previous patents), and that keywords in the claims of SEPs linked to the same standard become more similar after standard publication. Overall, these findings suggest widespread use of continuation procedures to opportunistically ”invent patents” that are infringed by already-published standards.

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1 Introduction

In 2018, just over 15 percent of all U.S. patent applications were continuations.[1] A continuation application seeks protection for new claims based on the invention disclosed in a prior "parent" application, using the parent's priority date to assess novelty and obviousness. In principle, continuations encourage early disclosure by allowing inventors to draft new claims when they have a better understanding of the technology and its commercial embodiments. In practice, continuations are one of the most controversial aspects of the U.S. patent system because they allow applicants to tailor their patent claims to cover products and technologies developed by others *after* an invention is disclosed.

Opportunistic use of continuations is widely discussed among patent attorneys and a frequent topic in policy debates. For example, in 2003 the U.S. Federal Trade Commission proposed creating "intervening or prior user rights" to protect parties from infringing claims arising from continuations (FTC 2003). In 2007, the U.S. Patent and Trademark Office (USPTO) proposed new rules that would sharply limit the use of continuations, but eventually withdrew the proposed changes after receiving substantial pushback from patent owners.[2] In a 2019 antitrust lawsuit, the pharmaceutical firm AbbVie was accused of using continuations to build an impenetrable patent "thicket" around its blockbuster drug Humira, including one chain of 22 continuations based on a single parent application.[3]

While these policy debates have produced many examples, there is little statistical evidence on the opportunistic use of continuations. The lack of systematic evidence reflects two fundamental measurement challenges: (i) it is hard to link patents to potentially infringing technologies, and (ii) it is difficult to observe clear milestones in the development of those technologies that provide incentives for applicants to seek new claims. We address these challenges by exploiting two features of the Information and Communications Technology (ICT) standardization process. First, several large Standard Setting Organizations (SSOs) encourage or require participants to disclose patents that might be infringed by a proposed standard, creating a link between patents and potentially infringing technology. Second, the publication of a standard provides an observable proxy for the date when uncertainty about product design is resolved. This study leverages these unique features of Standard Essential

[1] See Table 2 in Cotropia & Quillen (2019).

[2] Comments received by the USPTO are available at `https://www.uspto.gov/patent/laws-and-regulations/comments-public/comments-regarding-continuation-practice` (accessed May 8, 2020). For examples of the practitioner literature on continuation practice, see Michael T. Moore, "Use Strategic Continuation Practice to Monetize IP"' (Law360, April 3, 2015) or Michael Henry, "How to Slow Down Patent Prosecution with the USPTO" (`https://www.henrypatentfirm.com/blog/slow-down-patent-prosecution`, accessed May 8, 2020).

[3] *Fraternal Order of Police, Miami Lodge 20, et al. vs. AbbVie, Inc.*, para. 90-95 (available at `https://www.girardsharp.com/assets/htmldocuments/Humira%20Linked.pdf`, accessed January 4, 2021).

Patent (SEP) prosecution to provide systematic evidence on the use of "late claiming" via continuations.

We assemble data on the prosecution history of SEPs and similar technologies. In these data, 46% of SEPs are filed as continuations, and more than half of all SEPs are filed *after* the relevant standard was published. We also estimate difference-in-differences (DID) regressions that compare the probability of filing a continuation for SEPs relative to matched controls before and after the publication of a standard. The results indicate that standardization leads to a 80-121% increase in the probability of filing a continuation. This impact of standard publication on continuation filings is stronger for applications assigned to more lenient examiners. Moreover, it varies with the SEP owner's business model and is largest for firms that collect most of their revenue through licensing of Intellectual Property (IP). We interpret our DID results as evidence that patent applicants use continuations to opportunistically draft claims that cover standards published after the priority date of a parent application.

The final part of our analysis provides two bits of supporting evidence based on the examination process and the text of applications. First, we show that patent examiners are more likely to issue a non-statutory double patenting rejection for claims in SEP continuations filed after standard publication. As explained below, this type of rejection signals that applicants are seeking to modify the scope of claims filed in earlier patent applications. Second, we show that the claim language used in SEP continuation "converges" after a standard is published. Specifically, we construct a sample of post-standard continuations with pre-standard parents and then show that the pairwise textual similarity of claims in the continuations is greater than the textual similarity of claims in their parent applications.

Overall, our findings indicate widespread use of continuations to seek new patents that are infringed by already-published standards. It remains unclear how well this strategy works, in the sense of yielding patents that a court will find valid and essential. Indeed, Lemley & Simcoe (2019) find that the rate of infringement for SEPs and non-SEPs is very similar in a sample of U.S. lawsuits that reached a judgment on the merits. Their finding could indicate that many SEP continuations are not infringed by the standard, but might also reflect selection into litigation or a pattern of settling stronger cases. Regardless of whether SEP continuations yield truly essential patents, however, our findings highlight a prosecution strategy that is likely to reduce transparency during the standardization process, increase licensing transaction costs, and which raises questions about the usual narrative that the invention precedes the patent.

Our research contributes to three streams of literature on patents and standardization. First, prior literature on *continuations* explains how they can undermine invention disclosure, create opportunities for hold up, and more generally reallocate rents from downstream innovators to an initial patentee (Glazier 2003, Lemley & Moore 2004, Lemley & Shapiro 2005). Early empirical studies document the prevalence of continuations (Graham 2004), the types of applicants and technologies that use them (Hegde, Mowery & Graham 2009), and how they fit into patterns of patent prosecution (Graham & Mowery 2004). More recently, various authors have shown how continuations are associated with distortions in patent quality (Frakes & Wasserman 2015) and increased litigation (Marco & Miller 2019, Righi 2019). Relative to this prior literature, we innovate by identifying a setting where patents can be linked to a potentially infringing technology, and by proposing a strategy to identify how reduced uncertainty about infringement affects the propensity to file continuations.

Second, our research contributes to the literature on *strategic patenting* (Levin, Klevorick, Nelson, Winter, Gilbert & Griliches 1987, Cohen, Nelson & Walsh 2000, Hall & Ziedonis 2001, Ziedonis 2004) and specifically strategic behavior in SEP prosecution. Firms benefit from incorporating patented technology into standards because standardization eliminates competition from substitutes and lowers the cost of proving infringement (Rysman & Simcoe 2008, Lerner & Tirole 2015). This naturally leads to rent seeking in patent prosecution. For example, Kang & Bekkers (2015) and Kang & Motohashi (2015) show that firms often file patent applications just before standardization meetings and negotiate their inclusion into standards. Berger, Blind & Thumm (2012) find that a sample of declared SEPs filed at the European Patent Office (EPO) were amended more often than a set of matched control patents. Nagaoka, Tsukada & Shimbo (2009) show that a significant share of U.S. SEPs related to the MPEG2, DVD and W-CDMA standards are filed using continuations after the standards are set. Relative to this literature, our paper is more focused on the use of continuations, and is the first to propose an identification strategy for estimating the impact of standard publication on continuation filing. We also employ a larger sample of standards and SEPs, and are the first to analyze non-statutory double rejections, examiner leniency, and similarity in claim language.

Finally, we contribute to the literature on *patent scope* and *invention disclosure*. Menell & Meurer (2013) outline a general theory of "notice externalities" in patent prosecution, and a 2011 report by the U.S. Federal Trade Commission expressed many similar concerns (FTC 2011). In a series of empirical papers, Kuhn (2016), Kuhn & Thompson (2019) and Marco, Sarnoff & deGrazia (2019) use new data, measures and methods to investigate the determinants of patent scope, and its relation to commercial value. We show how companies use continuations not only to broaden the scope of protection, but also to increase the probability that subsequently developed technology will infringe.

In the next section of the paper, we provide more information on continuations and the standardization process. Section 3 describes the data, provides descriptive statistics on the timing of SEP filings, and describes our empirical strategy to estimate the impact of standard publication on SEP continuations. Sections 4 and 5 report the results of our analysis. Section 6 discusses policy implications and offers concluding remarks.

2 Institutional Setting

Inventors want patents that are valid yet broad, meaning they will withstand legal challenge and also cover as many uses of the invention as possible. To achieve these goals at reasonable cost, the basic strategy is to file early and delay claim drafting as long as possible.[4] Filing early creates a favorable priority date (i.e., the date a patent examiner uses to assess novelty and non-obviousness). Claims are not rejected based on technology disclosed after the priority date. Delayed claim drafting has several advantages. First, because most patent offices charge by the claim, the option to abandon is valuable to the applicant (Harhoff 2016). Second, when there is uncertainty about how an invention will be used, delay allows the applicant to draft claims corresponding to the most important uses of the invention. Third, delay allows applicants to tailor their claims to cover products or technology introduced by others during the pendency of the application, thereby increasing the probability of infringement.

The U.S. patent system provides several mechanisms for delayed claim drafting. A provisional patent application establishes priority, and provides applicants with up to one year to file a non-provisional application with specific claims. Applicants can also use international applications filed under the Patent Cooperation Treaty (PCT) to amend the claims in their US patent application for up to 30 months. Reissuance allows the patent owner to correct mistakes in an issued patent and to enlarge the scope of its claims if filed within two years of the original grant date. We focus on continuations because they provide greater flexibility and allow for longer delays, making them the most important means of delayed claim drafting.

Applicants can file a continuation at any time during the pendency of its parent application or during the pendency of that parent's previous children. Thus, by filing a "chain" of continuations, an inventor may seek new claims many years after the priority date of the original invention. The main limitations on this tactic are the roughly $6,500 cost of filing a continuation and the statutory patent term of 20 years from the priority date (which limits

[4] Claims are synonymous with scope because a patentee's exclusive right to make, use or sell extends only to whatever is specifically described in the claims of their patent (35 U.S.C. §100 and §112).

the useful life of any new claims).[5]

In principle, the USPTO will grant the claims in a continuation application only if they are supported by the disclosure in its parent. Specifically, the parent application must provide enough information for a "person having ordinary skill in the art" (PHOSITA) to make and use the claimed invention.[6] But many observers question whether patent examiners apply this rule consistently (FTC 2003, Glazier 2003, Chiang 2010). In particular, while a PHOSITA should be able to forecast all claims that emerge from a parent application, the written description of the invention in many applications employs vague or opaque language, and provides little hard technical information that could be used to predict the ultimate scope of the claims (Roin 2005, Seymore 2009).[7] When continuations lead to *unexpected* changes in patent scope, they become a means for applicants to obtain claims that read on technology developed by others. This reduces incentives to avoid infringement and creates a hold-up threat that can hinder follow-on innovation. In this study, our goal is not to assess the USPTO's overall performance at enforcing the enablement and written description requirements. Instead, we provide evidence that continuations are used opportunistically in at least one important context: standardization.

In the ICT sector, SSOs provide a forum where parties coordinate their R&D efforts and seek consensus on the design of standards that promote product interoperability. To avoid hold-up problems when standards incorporate patented technology, most SSOs have IP polices that either encourage or require participants to disclose patents that might be infringed by a proposed standard, and to license their essential patents on fair reasonable and non-discriminatory (FRAND) terms (Shapiro 2001, Lemley 2002, Bekkers, Catalini, Martinelli, Righi & Simcoe 2017).[8] We use these disclosures to link patent applications to a potentially infringing technology (the standard). This link is not perfect. Some disclosed patents are not truly essential, and some essential patents may not be disclosed. It is reasonable, however, to assume that most SSO participants would like their patents to become essential, because

[5]The precise cost of filing a continuation will depend on a number of factors, but several web sites suggest that attorney's fees will range from $3,000 to $6,000, while USPTO fees will amount to roughly $2,000. Among utility patents filed after 2000, the 99$^{\text{th}}$ percentile of the time-lag between priority date and continuation filing is 15 years.

[6]In patent law, this is called the "enablement" requirement: 35 U.S.C. §112(a).

[7]The PHOSITA's forecasting problem was especially severe before the American Inventor Protection Act (AIPA, 1999), which instituted publication of pending patent applications after 18 months. In one famous example, Chiron filed a patent application covering monoclonal antibodies in 1984 and used a string of continuations to expand its claims to cover types and uses of antibodies that were not understood at that time. It eventually asserted a patent based on a continuation application filed in 1999. See *Chiron Corp. v. Genentech, Inc., 268 F. Supp. 2d 1148 (E.D. Cal. 2002).*

[8]Although most SEPs in our study were disclosed to the European Telecommunications Standards Institute (ETSI), which has a policy of mandatory disclosure, a number of patents were disclosed to other SSOs where it is possible to offer FRAND licensing commitments without identifying specific patents.

it provides a number of benefits in both licensing and implementation.[9]

Formal approval and publication is a key event in the standard setting process. Publication indicates that a draft specification has become stable, and signals to implementers that they can safely commit to that design in their products (Layne-Farrar 2011, Simcoe 2012). In practice, some uncertainty will be resolved in technical meetings that predate formal publication. If one looks over a multi-year period, however, publication provides a good proxy for the moment when there is a sharp drop in uncertainty about the contents of a standard, and therefore the probability that a particular patent is essential. If SSO participants use continuations to opportunistically draft claims that cover the standard, this is when we should see a jump in that activity.

Before proceeding to the analysis, it worth pausing to discuss our use of the term "opportunism." Some readers may argue that no legal prosecution strategy can be opportunistic, or that opportunism requires any new claims to exceed the boundaries of the original disclosure. It is true that there is nothing illegal about strategic continuation practice. Indeed, some U.S. Courts seem to view it favorably.[10] It is also correct to observe that late-claiming is necessary, but not sufficient, to establish opportunism under a definition that requires a PHOSITA to be surprised.[11] However, these arguments beg the question of whose idea was embodied in the new claims, and why those claims were not part of the parent application? In a highly collaborative context, such as an SSO, it seems likely that continuations filed after publication of a standard often claim ideas for which others deserve at least a share of the credit. Moreover, some SSOs (including ETSI, the largest in our sample) encourage early disclosure of patents and specify procedures for removing or designing around patented technology when a FRAND commitment cannot be obtained. Such policies suggest that SSOs would prefer more clarity about claim scope during the specification drafting process — a goal that is undermined by continuations filed after standards are published.

[9]For licensing, essentiality provides a large addressable market and a simple way to prove infringement (i.e., by charting the patent against the standard). For implementation, using homegrown technology in the standard can yield lower costs and product development lead times.

[10]For example, in *Kingsdown Medical Consultants v. Hollister* (863 F.2d 867, Fed. Cir. 1988) the court writes, "there is nothing improper, illegal or inequitable in... amend[ing] or insert[ing] claims intended to cover a competitor's product the applicant's attorney has learned about during the prosecution of a patent application." See also *Gentry Gallery, Inc. v. Berkline Corp.* (134 F.3d 1473, Fed. Cir. 1998) or *Rambus, Inc. v. FTC* (522 F.3d 456, D.C. Cir. 2008) where this prosecution tactic was employed in the standard-setting context.

[11]It is not clear how we could measure whether a new claim was unanticipated, short of a case by case review. Prior research indicates that patent offices lacking access to SSO records struggle to identify relevant prior art (Bekkers, Martinelli & Tamagni 2020), and that some SSO participants have successfully patented ideas introduced by others (Granstrand 1999, p. 204). These findings do not speak directly to enablement, but do raise further questions about SEP validity and opportunism.

3 Data and Methods

3.1 Data sources and sample construction

Our main data source for information on SEPs is the Searle Center Database on technology standards and standard setting organizations (SCDB) (Baron & Gupta 2018, Baron & Pohlmann 2018, Baron & Spulber 2018). This database contains patents and patent applications declared essential to seventeen SSOs and thirteen patent pools.[12] For data on application characteristics, we use the 2017 release of the Patent Examination Research Dataset (Patex) (Graham, Marco & Miller 2018), which provides information on the applications in the Public Patent Application Information Retrieval system (Public PAIR) and covers filing activity through July 2018. We keep in our sample only utility patent applications.

Licensing commitments to SSOs usually cover all the members of a patent family (i.e., all applications sharing a common priority filing). We therefore define as SEPs the 22,869 U.S. utility patent applications from Patex that match to the SCDB dataset, along with all of their domestic family members, for a total of 31,943 applications. We link each family to a standard using the best match between disclosure letters and standards provided by Baron & Pohlmann (2018).[13] This yields complete information on the standard publication date (year and month) for 23,609 SEPs. Our sample for the analysis of the timing of SEP filings is restricted to SEPs filed in the post-AIPA period, which represents roughly 90% of the matches with a standard publication date. To identify the business model of the company making a SEP disclosure, we use company names to match these data to the Disclosed Standard Essential Patents (dSEP) Database (Bekkers et al. 2017). We also retrieve information on the claims of applications published between 2001 and 2014 from the Patent Claims Research Dataset (Marco et al. 2019) and the text of the claims from the PatentsView patent application database, which provides information on published applications as of July 15, 2016. Finally, we use the Office Action Research Dataset for Patents (Lu, Myers & Beliveau 2017) to identify the applications that receive a non-statutory double patenting rejection during the examination process.

[12]The SSOs covered by the SCDB are ANSI, ARIB, ATIS, Broadband Forum, CEN, DMTF, ECMA, ETSI, IEC, IEEE, IETF, ISO, ITUR, ITUT, OASIS, OMA and TIA. The patent pools include 3GPP-GERAN, AMRWB+, ATSC, AVC, BluRay, DVB-T, DVB-T2, DVD, MPEG DASH, MPEG Visual, SIPRO, VC1, and displayport.

[13]The link between patents and standards documents is described in detail in Section 3.3 of Baron & Pohlmann (2018). They provide both a document ID and a version number, because SSOs often publish several iterations of a given technical specification.

3.2 Descriptive statistics

Figure 1 provides an initial look at the relationship between standards and continuations in our dataset. To create the figure, we divide all SEPs into three groups based on the type of application: continuations (CON); applications that are not continuations, continuations-in-part, divisionals or reissues of another filing (Original); and a residual category (Other) for continuations-in-part, divisionals and reissues.[14] Within each group, we also divide the SEPs into those filed before versus after the earliest standard publication date associated with their patent family. Finally, as a point of comparison, we show the relative size of the three groups for all non-SEP applications examined by the Computers and Communication area of the USPTO. These three Technology Centers (2100, 2400 and 2600) examine roughly 90% of the SEPs in our sample.

Figure 1 reveals two important facts. First, SEPs are more likely to be continuations than a typical computer/communication application. Specifically, 46% of the SEPs are continuations, compared to only 18% of the reference group. One explanation is that standardization creates opportunities for strategic continuation filing that do not necessarily exist for non-SEPs. Second, many SEPs are filed after standard publication. For SEPs filed as continuations, 84% post-date standard publication. For Original applications, 30% are filed after the standard is published, indicating substantial use of provisional and PCT applications or of the 12-month grace period between invention disclosure and patent application filing allowed by U.S. patent law. Overall, 58% of SEPs are filed after the relevant standard is published.

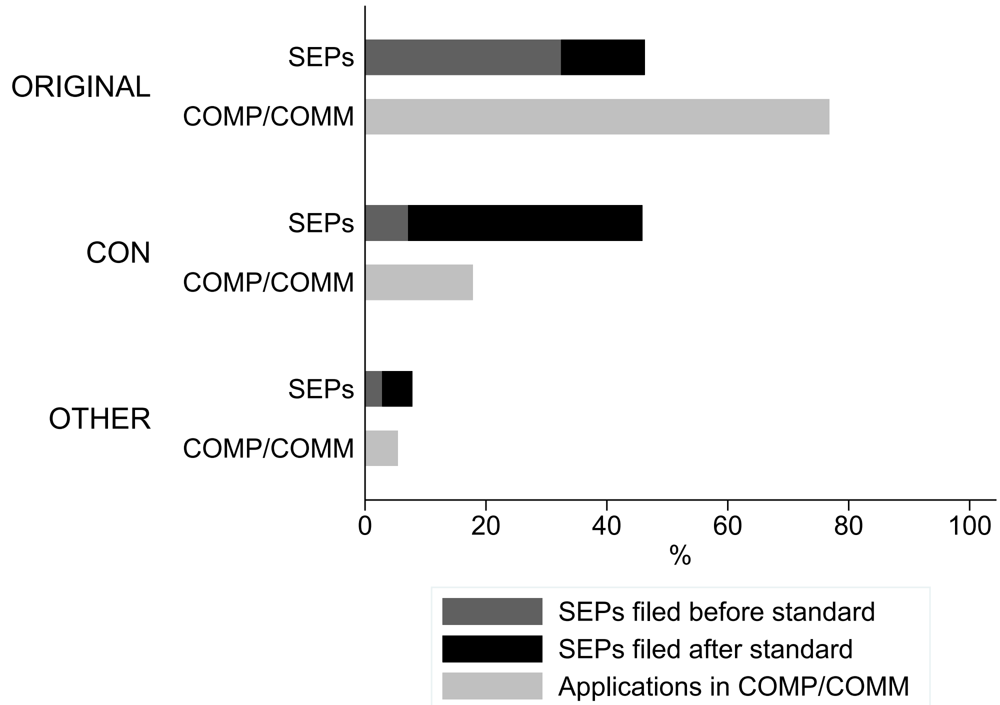
Figure A2 in the appendix shows the percentage of SEPs filed after standard publication (or filed as continuations) for all companies in our sample that own at least 100 SEPs.[15] We find substantial variation in "late filing" behavior by individual firms, with the share of SEPs filed after standard publication ranging from 27 to almost 80%. Many of the large SEP holders in our data file more than half of their SEPs after publication of the standard.[16]

[14]Continuations-in-part are applications that contain new claims on the invention disclosed in the parent application but also disclose new subject matter. Divisionals are applications filed because the original filing discloses more than one invention. Applications with a complex priority chain may be classified in more than one group. When an application is a continuation and a divisional, a continuation and a continuation-in-part, or a continuation and a reissue, we classify it as a continuation. Continuations that are also divisionals, continuations-in-part or reissues are respectively 6.2% of the SEPs and 2.3% of the applications in the Computers and Communications area of the USPTO used for Figure 1.

[15]These companies collectively own about 90% of the SEPs in our sample.

[16]Figures A1 and A3 show similar results using an alternative definition of SEP that includes only the patents and patent applications that are specifically mentioned in SSO disclosure letters (i.e. excluding undeclared U.S. family members of declared SEPs). Different versions of Figure 1 that use only granted patents or a 1-to-1 match between SEPs and control applications on filing month and technology center are almost identical to the figure reported in the text. For the latter version, we do not limit the control group to patents in Computers and Communications and pick a control at random if multiple controls are

Figure 1: Frequency and timing of SEP continuations



Notes. The sample contains utility patent applications filed on or after November 29, 2000. Percentages based on 21,199 SEPs and 1,447,286 (non-SEP) applications processed by Technology Centers 2100, 2400 and 2600. SEPs include U.S. utility patent applications declared essential for a standard, as well as all their parent and child applications. Pre- and post-standard SEPs defined using the earliest standard linked to a family of SEPs. Non-SEP applications are U.S. utility patent applications that are not in the patent family of a declared SEP.

3.3 Empirical strategy

In an experimental setting, one might randomly match pending patent applications with standards to ensure that potential outcomes are uncorrelated with SEP status. In practice, SEPs are not randomly chosen. SEPs are highly concentrated in ICT-related fields (Baron & Pohlmann 2018) and also selected for *ex ante* quality (Rysman & Simcoe 2008). Because more valuable patents are associated with larger families and more complex prosecution

available. Figure A4 plots the number of SEPs by type of application and by year of filing relative to the month of standard publication. The figure reveals that a large number of original applications linked to standards are filed just before standard publication, and that there is a large drop in this type of filings immediately after. The figure also shows that CON filings increase substantially after standard publication. This is consistent with the idea that patent applicants often file original applications just before standard publication to establish an early priority and later tailor the claims of continuations to the content of the standard.

histories, this creates concerns about omitted variable bias in a simple regression of continuation filing on SEP status (Putnam 1996, Harhoff, Scherer & Vopel 2003). To address these concerns, we use a combination of matching and DID regression.

We begin by identifying the earliest U.S. utility patent application in each family of SEPs, and keep only those with at least one filing in the U.S. patent family (the earliest and/or one of its children) still under examination in the quarter of publication of the earliest standard linked to the family. To construct a control group, we start with all non-SEP applications filed in the same quarter as a SEP identified at the previous step, excluding any application that claims priority to a previous U.S. utility patent application. To identify applications that cover similar technology to SEPs, we exploit the technological specialization of art-units and patent examiners within the USPTO. Specifically, we retain all applications in any filing-quarter-art-unit-examiner *strata* with at least one SEP and one control application.[17] This procedure leaves us with 53,112 applications (5,487 SEPs and 47,625 controls).

Applicants can file continuations as long as their original application or any of its children are pending. So, for each application in our sample, we retain information on continuations between its filing quarter and the latest disposal quarter of an application in its U.S. patent family (using data until the end of year 2016 to minimize truncation concerns related to delays in publication). This leaves a total of 959,733 application-quarter observations, in which the mean probability of continuation filing is 1.2%. About 14% of the applications in this sample have one or more continuations during the sample period. The mean number of continuations per application is 0.77 for the SEPs and 0.18 for the controls.

In addition to this baseline sample, we create a second matched control sample where the number of continuation filings prior to standard publication is the same for SEPs and controls by construction. Specifically, for each SEP we randomly select a single control application in the same filing-quarter-art-unit-examiner *stratum* having in the quarter before standard publication (i) at least one filing in the U.S. patent family still under examination, and (ii) the same cumulative number of continuations filed.[18] We match almost 92% of the SEPs with a control, discarding 460 SEPs. Relatively few SEPs (9%) have continuations before standard publication, and it is difficult to find controls for SEPs with a high number of pre-standard continuations. So this procedure discards a large share of the SEPs with a continuation in the pre-standard periods (arguably, the most valuable).[19]

[17]Art-units are groups of examiners who process relatively similar technologies, and within art-units examiners often specialize in certain technological areas (Cockburn, Kortum & Stern 2002, Lemley & Sampat 2012, Righi & Simcoe 2019). Comparing applications assigned to the same art-unit and examiner also reduces the possible influence of systematic differences in examination style that may be related to the eventual inclusion of a technology into a standard (Kuhn & Thompson 2019).

[18]We match without replacement and break ties at random.

[19]Specifically, we match with a control application only 34% of the SEPs with at least one continuation

Our baseline empirical specification is a linear probability model. For application i with filing-quarter-art-unit-examiner j we estimate

$$CON_{it} = SEP_i \times (\alpha + \beta PostStandard_{it}) + \gamma_{j(i)} + \delta_t + f(age_{it}) + \varepsilon_{it} \quad (1)$$

where the outcome CON_{it} is an indicator equal to one if application i has a continuation filed in quarter t, SEP_i is an indicator equal to one for SEPs, and $PostStandard_{it}$ is an indicator equal to one starting in the quarter of publication of the earliest standard linked to the patent family of application i.[20] When using the sample matched on pre-standard continuations, we also add the main effect of $PostStandard_{it}$ to Equation 1, using the standard publication date of the matched SEP to define this variable for each control.

We consider three variants of Equation (1). The first is a pooled cross-sectional model with calendar-quarter effects, δ_t, to control for common trends, and a full set of application-age (i.e., calendar quarter minus filing quarter) effects to control for the baseline hazard of continuation filing. In the second variant, we add art-unit-examiner-filing-quarter effects, γ_j, and because age is co-linear with filing and calendar quarter, replace the age effects with the non-linear terms of a fourth-order polynomial $f(\cdot)$ in age. The third variant replaces γ_j with a full set of application effects γ_i to control for any time-invariant differences across applications (e.g. technology value or technological field). In all of our models, we cluster the residual term, ε_{it}, by application and multiply CON_{it} by 100 for an easier interpretation of the coefficient α as a percentage point change in the probability of continuation filing.

Under a parallel trends assumption, the coefficient β in Equation (1) measures the impact of standard publication on the probability of filing a continuation (i.e. the average treatment effect for treated applications). In order to test the parallel trends assumption on pre-standard data and examine the dynamic treatment effects, we also estimate an event study version of this DID model using the following OLS regression

$$CON_{it} = \sum_{\tau=-8}^{8} (\alpha_\tau + \beta_\tau SEP_i) + \gamma_i + \delta_t + f(age_a) + \varepsilon_{it} \quad (2)$$

where, using the sample matched on pre-standard continuations and assigning the standard publication date of the matched SEP to each control, the α_τ's are dummies equal to one τ quarters before/after standard publication. The coefficients β_τ measure the difference in the probability of continuation filing between SEPs and controls before ($\tau < 0$) and after ($\tau \geq 0$) standard publication. For both the α_τ's and the β_τ's, the omitted category is the quarter

in the pre-standard period, and none of those with more than 3.

[20] Although we could model the outcome as a count variable, it is extremely rare for an application to spawn multiple continuations in the same quarter.

before standard publication ($\tau = -1$), and we focus on a four-year window around standard publication, using a single indicator for $\tau \leq -8$ and a single indicator for $\tau \geq 8$. When we use the baseline sample to estimate this equation, we omit the α_τ's because the controls do not have an associated standard publication date. All other variables are defined above.[21]

4 Results

4.1 Graphical evidence

Figure 2 provides graphical evidence of the link between standard publication and continuation filing. Specifically, we plot the quarterly probability of continuation filing for both SEPs and controls in a four-year window around standard publication. In order to assign a publication date to the controls, we match each SEP to a single control and use the publication date for the matched SEP's standard. For panel (a), we randomly match each SEP with a control filed in the same quarter and assigned to the same examiner in the same art-unit.[22] For panel (b), we use the 1-to-1 match described above, which ensures that SEPs and controls have the same cumulative number of pre-standard continuations.

Panel (a) in Figure 2 shows that the baseline probability of continuation filing increases over time for both SEPs and controls. Although SEPs are more likely to generate a continuation both before and after standardization, the difference clearly increases in the post-standard time-period. In fact, it appears that the relative rate of continuation filings for SEPs starts to increase a year or more before publication, consistent with the idea that key design commitments actually occur prior to formal approval and publication of the standard. Participants in the standardization process may also anticipate the final design and begin to file continuations before a standard is formally approved.

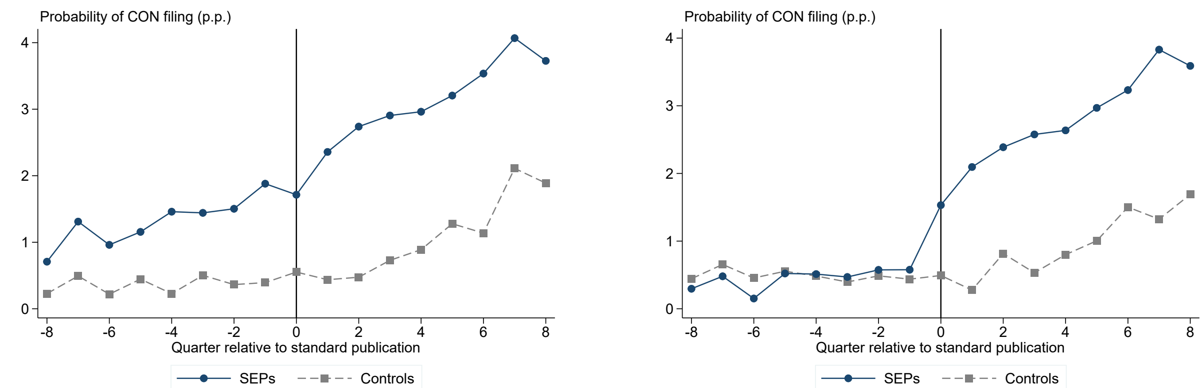
Panel (b) of Figure 2 shows that after matching SEPs and controls on the number of pre-standard continuations, the two groups are on the same trend before standard publication, and there is still a substantial increase in the probability of continuation filings for the SEPs after standard publication. Next, we analyze these patterns in a regression framework.

[21] We estimate all models that include fixed effects using the estimator described in Correia (2016), which allows a very fast estimation of linear regressions with high-dimensional fixed effects.

[22] We match without replacement and break ties at random. We match 99% of the SEPs with a control, discarding only 66 SEPs.

Figure 2: Continuation filings around standard publication

(a) Controls picked randomly (b) Controls matched on continuation filings



Notes: This figure plots the average probability of continuation filing for SEPs and controls in each quarter in a 4-year window around standard publication (for controls, we use the publication date of the matched SEP). A SEP is the earliest U.S. utility patent application of a domestic patent family that contains at least one U.S. utility patent application declared essential for a standard. A control application is the earliest U.S. utility patent application of a domestic patent family that does not contain any U.S. utility patent applications declared essential for a standard. The quarter of standard publication is the quarter of publication of the earliest standard linked to a family of SEPs. In panel A we use as control for each SEP an application in the same art-unit-examiner-filing-quarter group picked at random. In panel B we use as control for each SEP an application in the same art-unit-examiner-filing-quarter group with a pending family (i.e. at least one filing in the U.S. patent family is still under examination) and the same cumulative number of CONs filed in the quarter before standard publication. An application is included in the sample from its filing quarter to the latest disposal quarter of an application in its U.S. patent family, or the end of year 2016 if its family is still pending.

4.2 Difference in differences estimates

Table 1 shows coefficient estimates from our DID models, using the two samples described above. The first column is based on a pooled cross-sectional regression. The coefficients indicate that the quarterly probability of continuation filing is 0.8 percentage points higher for SEPs before standard publication. The DID estimate indicates that standardization produces a 1.13 percentage point increase in the probability of filing a continuation, which corresponds to a 93% increase in the baseline probability. In the second column, we add art-unit-examiner-filing-quarter effects to control for technological heterogeneity and differences among cohorts, and find similar estimates. The third column adds application effects, which absorb the SEP indicator. In this specification, the DID estimate grows to 1.5 percentage points, more than doubling the baseline probability.

Table 1: Difference in differences models of continuation filing

Outcome	CON × 100					
Specification	OLS					
Sample	SEPs and Controls			SEPs and Controls matched on Pre-standard CONs		
Model	Pooled OLS (1)	Tech & cohort FE (2)	Application FE (3)	Pooled OLS (4)	Tech & cohort FE (5)	Application FE (6)
PostStandard × SEP	1.13***	0.98***	1.48***	2.02***	1.89***	1.97***
	(0.09)	(0.09)	(0.09)	(0.11)	(0.09)	(0.11)
SEP	0.80***	0.91***		0.00	0.00	
	(0.05)	(0.05)		(0.04)	(0.04)	
Quarter FE	✓	✓	✓	✓	✓	✓
Age FE	✓			✓		
AU-E-FQ FE		✓			✓	
Age^2, age^3 & age^4		✓	✓		✓	✓
Application FE			✓			✓
PostStandard				✓	✓	✓
Observations	959,733	959,733	959,733	211,339	211,339	211,339
R-squared	0.02	0.03	0.07	0.02	0.05	0.07
Applications	53,112	53,112	53,112	10,054	10,054	10,054
Mean of outcome	1.22	1.22	1.22	1.91	1.91	1.91

Notes. The unit of observation is an application-quarter. An application is included in the sample from its filing quarter to the latest disposal quarter of an application in its U.S. patent family, or the end of year 2016 if its family is still pending (i.e. at least one filing in the U.S. patent family is still under examination). A SEP is the earliest U.S. utility patent application of a domestic patent family that contains at least one U.S. utility patent application declared essential for a standard. A control application is the earliest U.S. utility patent application of a domestic patent family that does not contain any U.S. utility patent applications declared essential for a standard. The sample for models (1)-(3) contains SEPs whose family is pending at standard publication and control applications in art-unit-examiner-filing-quarter groups with at least one SEP and one control. The sample for models (4)-(6) contains SEPs whose family is still pending at standard publication and control applications whose family is still pending in the quarter before standard publication matched on filing quarter, art unit, examiner and cumulative number of continuations in the quarter before standard publication. The quarter of standard publication is the quarter of publication of the earliest standard linked to a family of SEPs. Standard errors clustered by application in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Columns (4) through (6) of Table 1 report estimates from similar models, using the matched sample and adding the main effect of the standard publication dummy. The mean outcome in this sample is about 50% larger, and the coefficient on the SEP indicator is approximately zero by construction. The DID coefficient in all three specifications is roughly 2, which corresponds to an increase in the probability of a continuation filing by about 100%.[23]

[23] Chabé-Ferret (2017) shows that including unit fixed effects in DID models after matching on pre-

Overall, the DID estimates uniformly indicate that there is an economically and statistically significant increase in SEP continuations filed after standards are published.

4.3 Event studies

Event study models can provide a closer look at the precise timing of the increase in SEP continuation filings. Figure 3 plots the β_τ's from four versions of Equation (2). The top row shows results for the baseline sample, using either the indicator SEP_i and a full set of age effects (panel a), or application fixed effects and an age polynomial (panel b). The bottom row graphs estimates for similar models, using the sample of SEPs and controls matched on pre-standard continuations, and adding the α_τ's to the regressions.

All four models show a sharp jump in the probability of a SEP continuation filing immediately after standard publication. Panels (a) and (b) also show an increasing trend in SEP continuations prior to standard publication. For panel (a), an F-test of the hypothesis that all pre-publication coefficients are jointly equal to zero rejects the parallel-trends assumption (p=0.05), although we do not reject the hypothesis that the coefficients β_{-8} through β_{-2} are equal to each other (p=0.37). As described above, an increase in continuations just before standard publication could reflect the resolution of design uncertainty prior to formal approval.[24] For panel (b), both tests reject the parallel trend hypothesis at the 1 percent level.

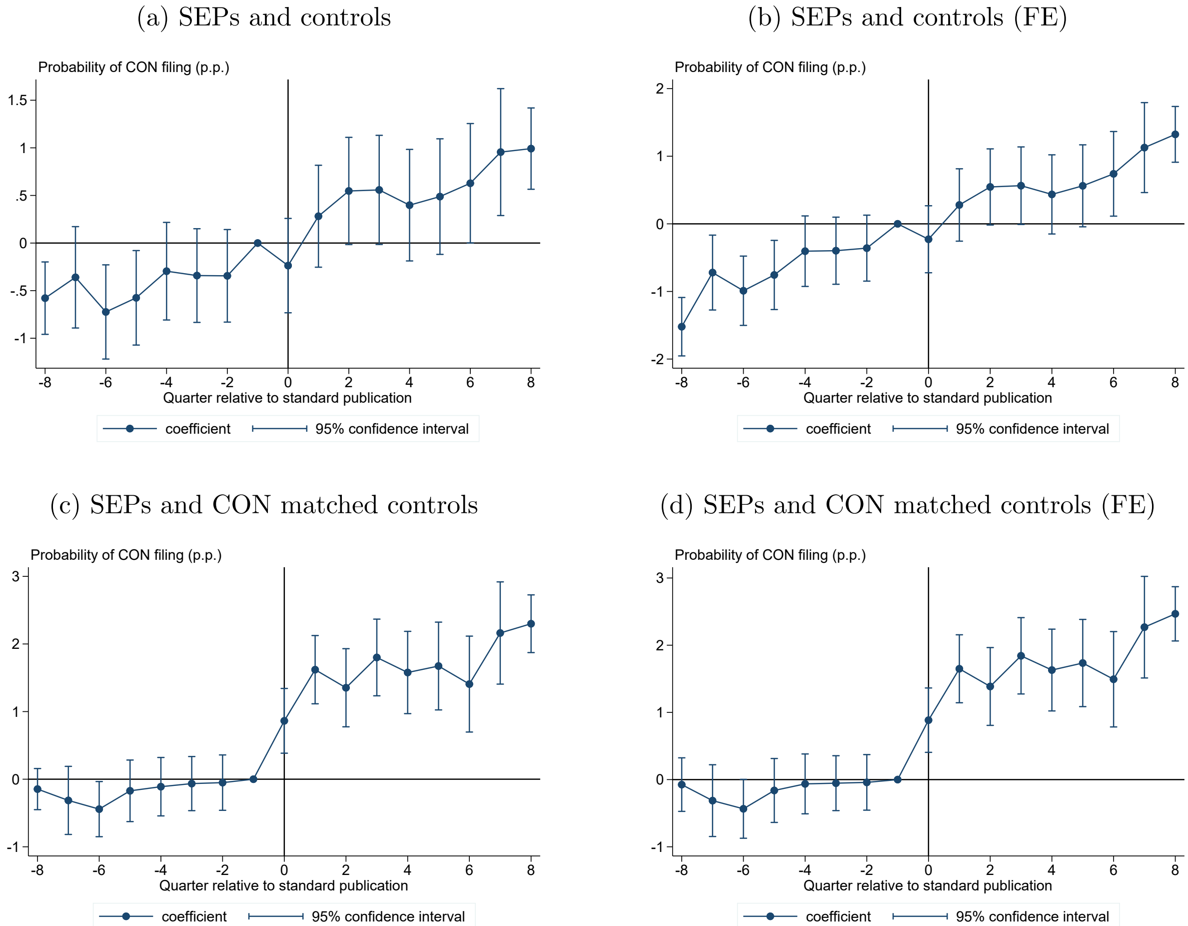
In panels (c) and (d) we match on the cumulative number of pre-publication continuations (which, in practice, is typically zero or one). For this sample, we cannot reject the hypothesis of parallel pre-trends.[25] Following standard publication, we continue to find a sharp increase in the probability of a continuation filing. We interpret the matched sample event study results as strong evidence of opportunistic use of the continuation procedure to seek claims covering technology that has been included in a standard.

treatment outcomes may introduce bias. Our estimates suggest this is not a concern in our analysis.

[24]To the extent that our definition of treatment (i.e., $\tau = 0$) is a little "too late" that measurement error will bias our baseline DID estimates towards zero.

[25]F-tests cannot reject the null hypothesis that the pre-standard coefficients for the SEPs are jointly equal to zero, with p-value=0.49 for panel C and p-value=0.54 for panel D.

Figure 3: Continuation filings around standard publication, DID models



Notes. Each panel plots the β_τ's and their 95% confidence intervals from OLS regressions based on Equation 2. Models for panels (a) and (b) are estimated on the sample for models (1)-(3) in Table 1. Models for panels (c) and (d) are estimated on the sample for models (4)-(6) in Table 1. Panels (a) and (c) report the estimates for pooled cross-sectional models. Panels (b) and (d) report the estimates for the models with application fixed effects.

4.4 Examiner leniency

Although patent examiners have a uniform mandate, in practice they have substantial discretion in how to deal with an application, and prior research has found that this leads to large differences in patenting outcomes (Feng & Jaravel 2020, Kuhn & Thompson 2019, Lemley & Sampat 2012, Sampat & Williams 2019). Because patent examination involves several rounds of negotiation between applicant and examiner, we might expect that an applicant can learn something about the type of examiner on a given application, and tailor their prosecution strategy accordingly. In particular, an applicant should be more willing to file a continuation when facing a "lenient" examiner who is more likely to allow the new claims.[26] In our setting, this suggests firms will be even more likely to file a post-standard continuation when they receive a favorable draw from the distribution of examiner leniency.

To test this idea, we compute a measure of leniency based on each examiner's propensity to grant broad patents. Specifically, for each application in our data, we identify all post-AIPA patents granted by the same examiner (excluding patents in the same family as the focal application) and compute the average difference between the number of independent claims at issuance and at publication.[27] Patents with more independent claims have broader scope because they protect more technological embodiments of an invention. The number of independent claims typically declines during examination, based on rejections by the examiner, so higher values of this variable represent a more lenient approach to examination (Marco et al. 2019). We standardize this measure of examiner leniency (for ease of interpretation), and re-estimate the DID models adding a three-way interaction between leniency and the $PostStandard_{it} \times SEP_i$ indicator. Results are in Table 2.

Across all models, the increase in continuation filings after standard publication is larger for applications assigned to more lenient examiners: a one standard deviation increase in examiner leniency is associated with a 0.6 percentage point increase in the probability of continuation filing (roughly half the size of the main treatment effect).[28] Interestingly, the main effect of examiner leniency in the pooled OLS models is relatively small. Taken together, these results suggest that applicants wait to take advantage of lenient examiners until they have better information on the content of the standard. To our knowledge, this is the first paper to test the idea that applicants learn about examiner leniency during the examination process. Moreover, in the SEP context, we interpret these findings as evidence that applicants exploit strategically what they learn during examination to modify the scope of patent protection on the standards.

[26] This logic requires, of course, that the examiner on the parent application is also assigned to the continuation. This is often true in practice. In particular, roughly 75 percent of the post-AIPA continuations filed at the USPTO are assigned to the same examiner of the earliest application in their priority chain.

[27] To compute this measure, we use information on granted patents for which we observe also the published application and are included in the the Patent Claims Research Dataset (Marco et al. 2019). We use all the post-AIPA patents granted by an examiner because, although the leniency of an examiner is affected by time-varying factors such as experience, time available to review applications or peer effects, it tends to be very persistent over time (Frakes & Wasserman 2016, Frakes & Wasserman 2017*a*, Frakes & Wasserman 2017*b*, Lemley & Sampat 2012). Moreover, measuring leniency at a specific point in time would require arbitrary choices because the examination of an applications often spans several years. We exclude from the analysis all applications where our measure of leniency is computed using less than 10 applications.

[28] We obtain very similar results using an alternative measure of leniency based on examiners' leave-one-out grant rates, as in Sampat & Williams (2019). See Table A12 for details.

Table 2: **Heterogeneous effects by examiner leniency**

Outcome Specification	CON × 100 OLS					
Sample	SEPs and controls			SEPs and controls matched on pre-standard CONs		
Model	Pooled OLS (1)	Tech & cohort FE (2)	Application FE (3)	Pooled OLS (4)	Tech & cohort FE (5)	Application FE (6)
PostStandard × SEP × Leniency	0.60*** (0.10)	0.61*** (0.07)	0.59*** (0.09)	0.57*** (0.12)	0.56*** (0.06)	0.57*** (0.10)
PostStandard × SEP	1.11*** (0.09)	0.97*** (0.09)	1.48*** (0.10)	2.01*** (0.11)	1.89*** (0.09)	1.97*** (0.11)
SEP	0.81*** (0.05)	0.91*** (0.05)		0.00 (0.05)	0.00 (0.04)	
Leniency	0.08*** (0.02)			0.07 (0.07)		
Quarter FE	✓	✓	✓	✓	✓	✓
Age FE	✓			✓		
AU-E-FQ FE		✓			✓	
Age^2, age^3 & age^4		✓	✓		✓	✓
Application FE			✓			✓
PostStandard				✓	✓	✓
Observations	942,154	942,154	942,154	207,584	207,584	207,584
R-squared	0.02	0.03	0.07	0.02	0.05	0.07
Applications	51,799	51,799	51,799	9,796	9,796	9,796
Mean of outcome	1.23	1.23	1.23	1.92	1.92	1.92

Notes. The unit of observation is an application-quarter. See Table 1 for the description of the samples. We keep in the samples the applications whose examiner issues at least 10 patents outside the focal family for which we can compute the change in the number of independent claims between publication and issuance, and keep in the sample art-unit-examiner-filing-quarter groups with at least one SEP and one control after this restriction (models (1)-(3)), and matched pairs where both applications meet this additional criterion (models (4)-(6)). Standard errors clustered by application in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4.5 Business models

If continuations are used to obtain SEPs, it is natural to ask what sort of applicants are doing so. The dSEP database classifies SEP-owner business models into nine categories. We focus on the largest three in our sample: (i) product suppliers, product vendors and system integrators (3,516 SEPs); (ii) components (942 SEPs); (iii) pure upstream knowledge developer or patent holding company (415 SEPs). We pool together all of the smaller categories, along with SEPs that we cannot match to dSEP, into a residual category (614

SEPs). We then re-estimate the models in Table 1, interacting $PostStandard_{it} \times SEP_i$ and SEP_i with a dummy for each business model category.[29] Results are in Table 3.

The estimates in columns (1) and (2) show that SEPs have a higher pre-publication rate of continuation filings than the controls across all business model types. Patent holding companies, which base their business model on licensing of IP, have the highest baseline rate of continuation filings, although we cannot reject the hypothesis that any of the baseline SEP continuation rates are equal at a 5% significance level.

Across all six models, the two groups with the highest correlation between standard publication and continuation filing are patent holding companies and product suppliers.[30] Patent holding companies have the largest DID coefficient in all models, and the difference between patent holding companies and product suppliers is statistically significant at conventional levels in models (3)-(6).[31] Patent holding companies have incentives to use continuations strategically to increase their licensing revenues. Interestingly, and perhaps surprisingly given the importance of IP to their business models, the correlation between standard publication and the probability of continuation filing is negative or not statistically different from zero for producers of components. This result suggests that different types of "upstream" players have different strategies regarding continuations. A plausible explanation for the relatively large coefficient for product suppliers is that downstream players have an incentive to inflate their SEP portfolios to protect their investments from hold-up risks, increase their bargaining power in cross-licensing negotiations, and obtain freedom to operate (Hall & Ziedonis 2001, Shapiro 2001, Ziedonis 2004).

[29] If a SEP is associated with multiple companies, we use the business model of the first company in alphabetical order. The results are robust to excluding these 40 SEPs.

[30] Statistical tests reject the equality of those coefficients with the coefficients of standard publication for components and the residual category "other" at least at 10% in all models.

[31] The p-values for a test of the null hypothesis that the two coefficients are equal are 0.18 for model (1), 0.19 for model (2), and lower than 0.03 in the other models.

Table 3: Heterogeneous effects by business model

Outcome	CON × 100					
Specification	OLS					
Sample	SEPs and controls			SEPs and controls matched on pre-standard CONs		
Model	Pooled OLS	Tech & cohort FE	Application FE	Pooled OLS	Tech & cohort FE	Application FE
	(1)	(2)	(3)	(4)	(5)	(6)
PostStandard × SEP × patent holding company	2.08***	1.89***	2.97***	3.27***	3.23***	3.59***
	(0.32)	(0.28)	(0.34)	(0.29)	(0.29)	(0.34)
PostStandard × SEP × components	-1.08***	-1.19***	-0.50***	-0.42***	-0.45***	-0.23
	(0.16)	(0.14)	(0.16)	(0.15)	(0.14)	(0.16)
PostStandard × SEP × products	1.62***	1.49***	1.90***	2.57***	2.43***	2.49***
	(0.12)	(0.11)	(0.12)	(0.13)	(0.11)	(0.13)
PostStandard × SEP × other	0.68***	0.58***	1.37***	1.38***	1.32***	1.51***
	(0.24)	(0.23)	(0.26)	(0.24)	(0.22)	(0.25)
SEP × patent holding company	1.06***	1.00***		0.12	-0.25	
	(0.24)	(0.19)		(0.16)	(0.20)	
SEP × components	0.68***	0.82***		0.01	0.13	
	(0.12)	(0.10)		(0.09)	(0.08)	
SEP × products	0.85***	0.94***		0.02	0.02	
	(0.07)	(0.06)		(0.05)	(0.06)	
SEP × other	0.58***	0.70***		-0.16**	-0.18	
	(0.14)	(0.14)		(0.07)	(0.12)	
Quarter FE	✓	✓	✓	✓	✓	✓
Age FE	✓			✓		
AU-E-FQ FE		✓			✓	
Age^2, age^3 & age^4		✓	✓		✓	✓
Application FE			✓			✓
PostStandard				✓	✓	✓
Observations	959,733	959,733	959,733	211,339	211,339	211,339
R-squared	0.02	0.03	0.07	0.03	0.05	0.07
Applications	53,112	53,112	53,112	10,054	10,054	10,054
Mean of outcome	1.22	1.22	1.22	1.91	1.91	1.91

Notes. The unit of observation is an application-quarter. See Table 1 for the description of the samples. Standard errors clustered by application in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4.6 Robustness checks

We conduct a series of robustness checks, described briefly here, with a full discussion and all results provided in the appendix. Across all of these models, we find a robust association between standard publication and the probability of filing a SEP continuation.

First, we consider an alternative definition of SEP that includes *only* patents or patent applications explicitly mentioned in a disclosure letter to an SSO (Table A2). Second, we change the outcome variable to an indicator for any type of child application — including continuations-in-part, divisionals and reissues – as opposed to just continuations (Table A3). Third, we add controls for a number of observable application characteristics that may be related to both SEP status and the propensity to file continuations (Table A4). Fourth, we estimate models that include four leads of an indicator equal to one for SEPs in the quarter of standard publication, to measure any anticipation effects (Table A5). Fifth, because continuation is a rare outcome, we estimate a series of piecewise constant hazard models, where the outcome is the probability of continuation conditional on not having any prior continuations, and applications are removed from the sample after the first observed continuation (Tables A6–A8). Finally, we estimate models similar to those in the main analysis and in the previous robustness checks using samples that contain only SEPs filed before standard publication (Tables A9–A11).

5 Claim drafting

Thus far, our evidence that applicants use continuations opportunistically is largely based on timing. This section provides further (indirect) evidence of opportunistic claim drafting based on the examination process and the text of claims. First, we show that patent examiners are more likely to reject claims in SEP continuations filed after standard publication than those in other continuations using a particular type of rejection that signals an attempt to change patent scope on technologies already protected with previous patents. Second, we show that the textual similarity of the claims in continuations filed after the publication of a common standard is greater than the textual similarity of claims in their parents filed before standard publication.

5.1 Double patenting rejections

Patent examiners may reject a claim if the same inventor has disclosed "patentably indistinct" claims in a previous application.[32] This is called a non-statutory or obviousness-type

[32] See the *Manual of Patent Examination Procedure*, Title 37 Code of Federal Regulations, Section 1.78.

double patenting rejection, and it is meant to prevent applicants from extending the term of a first patent by including similar claims in a later application. Non-statutory double patenting rejections often occur when an applicant seeks to change the scope of its earlier claims, for example expanding it by removing some limitations. We therefore take these rejections as a proxy for "claim broadening" or "claim tailoring" continuation applications (as opposed to continuations that claim new and distinct uses of the original invention).[33] If applicants use continuations opportunistically after they know the content of related standards, we would expect to see more non-statutory double-patenting rejections for SEP continuations filed after standard publication than before.

To test this hypothesis, we construct a sample of SEP and control continuations that are technologically similar and exposed to a similar examination environment. We start from the sample of SEP continuations described in section 3.2, matching each SEP continuation with a non-SEP continuation filed in the same year, and assigned to the same art unit and examiner.[34] In order to observe the full examination history of each application, which we obtain from Lu et al. (2017), we exclude all continuations filed before 2008 or disposed after June 2017. We also exclude all applications where the examiner leniency measure described above is computed using less than 10 applications. This process yields an analysis sample containing 10,496 continuation applications. Using this sample, we estimate linear probability models where the outcome is equal to one if a continuation receives a non-statutory double patenting rejection (multiplied by 100 for an easier interpretation of the coefficients), and the main explanatory variables are two indicators equal to one for SEP continuations filed, respectively, before and after the month of standard publication. The results appear in Table 4.

Column 1 shows that post-standard SEP continuations are about 8 percentage points more likely than the non-SEP continuations to receive a non-statutory double patenting rejection. This is a 16% increase relative to the 50% baseline probability of a double-patenting rejection. Pre-standard SEP continuations, on the other hand, are about 5 percentage points *less* likely to receive a non-statutory double patenting rejection than the non-SEP controls.

[33] We are indebted to Jeffrey Kuhn for suggesting this outcome variable.

[34] We perform a 1-to-1 match without replacement, breaking ties at random. We match about 93% of the SEP continuations available after the exclusions described in the main text.

Table 4: Regression models of non-statutory double patenting rejection

Outcome	Non-statutory double patenting rejection ×100		
Specification	OLS		
Model	Baseline	Leniency & controls	Examiner FE
	(1)	(2)	(3)
SEP post-standard	7.81***	7.17***	7.27***
	(1.15)	(1.09)	(1.00)
SEP pre-standard	-4.85**	-0.93	-1.58
	(2.03)	(2.06)	(1.98)
Leniency		-1.64**	
		(0.71)	
Art unit effects		✓	✓
Filing year effects		✓	✓
Examiner effects			✓
Observations	10,496	10,496	10,496
R-squared	0.01	0.08	0.24
Patent families	8,131	8,131	8,131
Mean of outcome	49.90	49.90	49.90

Notes. The unit of observation is a patent application. The sample contains continuations filed after year 2007 and disposed before July 2017. We match SEP and non-SEP continuations on art unit, filing year, and examiner. We match without replacement and break ties at random. SEPs include U.S. utility patent applications declared essential for a standard, as well as all their parent and child applications. Pre- and post-standard SEPs defined using the earliest standard linked to a family of SEPs. Non-SEP applications are U.S. utility patent applications that are not in the patent family of a declared SEP. Standard errors clustered by patent family in parentheses. *** p<0.01, ** p<0.05, * p<0.1

In column 2, we add art unit and filing year effects, along with our measure of examiner leniency based on the propensity of an examiner to reject independent claims. The coefficient of the post-standard SEP continuation dummy is very similar to column 1. The coefficient of the pre-standard SEP continuation dummy, however, becomes indistinguishable from zero. And we find that a one standard deviation increase in examiner leniency is associated with 1.64 percentage point reduction in the probability of a double-patenting rejection. Finally, in model 3 we add examiner fixed effects and find similar results. We interpret these estimates as further evidence that SEP applicants use continuations to opportunistically modify the scope of patent protection after they know the design of a standard.[35]

[35]We also construct a matched sample containing not only continuations but also other types of applications, matching SEPs and controls also on the type of application — original, continuation or the residual category "other." The results are similar to those reported in the paper. Figure A5 shows graphically that continuations, in general, have a much higher probability of receiving a non-statutory double patenting rejection than other types of applications, and that post-standard SEP continuations in particular have the highest rate of non-statutory double patenting rejections.

5.2 Claim language convergence

The final part of our empirical analysis focuses on the actual text of the patent application claims. In order to ascertain whether applicants are, in fact, using continuations to draft claims that read on published standards, one could read the original disclosure, the new claims, and the relevant standards. Unfortunately, that is a very time-intensive process requiring access to the text of standards and also expertise in interpreting patent claims.[36] As an alternative, we measure the similarity of claims across pairs of applications linked to the same standard, and compare the similarity of claims filed before versus after standard publication. If applicants are drafting claims that read on the standard, our hypothesis is that claim language should converge after the standard is published.[37]

Suppose k indexes pairs of continuations essential for the same standard, both continuations are filed after standard publication, and each has a parent application filed before standard publication. Our measure of claim similarity is a Jaccard index (Arts, Cassiman & Gomez 2018), which equals the number of common keywords in the claims of the two applications divided by the number of total keywords, multiplied by 100. For each application pair k we define two similarity scores: J_k^{post} is the similarity of the two post-standard continuations, and J_k^{pre} is the similarity of the two pre-standard parent applications.[38] We retain all pairs where the two continuations and their parents have at least 10 keywords and drop all pairs where the two continuations claim priority to the same parent. This leaves us with a sample of 661,789 pairs.

For this sample of application-pairs, the mean of J_k^{pre} is 13.17 and the mean of J_k^{post} is 15.34. Pooling together J_k^{pre} and J_k^{post}, we find that the difference in means is equal to 0.31 standard deviations of J_k (t-stat=295). We also create a sample with two observations for each pair k — one observation for the post-standard continuations and one for their pre-standard parents — and compare the Jaccard similarities using OLS regressions.

[36] Brachtendorf, Gaessler & Harhoff (2019) pursues a similar approach based on automated text matching.

[37] We do not have strong priors as to whether the claims in a continuation would be "broader" or "narrower" than the claims in its parent: this likely depends on the (unobserved) relationship of the original claims to the standard. For this reason, we do not analyze text-based measures of claim scope.

[38] We use all the families of SEPs in our data and adapt the procedure described in Arts et al. (2018) to extract a set of unique keywords from the claims of each application. We also use all standards in our data, but drop duplicates when the same pair is related to multiple standards.

Table 5: Regression models of Jaccard similarity

Outcome	Jaccard similarity		
Specification	OLS		
Model	No controls	Pair FE	Application characteristics
	(1)	(2)	(3)
Post-standard CONs	2.17***	2.17***	0.74***
	(0.01)	(0.01)	(0.06)
Pair FE		✓	✓
Claims, technology, year			✓
Observations	1,323,578	1,323,578	419,142
R-squared	0.02	0.82	0.83
Pairs	661,789	661,789	209,571
Mean of outcome	14.26	14.26	12.51

Notes. The sample contains two observations for each pair of post-standard continuations, one for the two continuations and one for their parents. The control variables for model (3) are defined at the application level, i.e. measured separately for the two applications of each observation. Controls include filing year effects, art-unit-by-examiner effects, and the natural logarithms of the number of independent claims and the number of words per independent claim. Standard errors clustered by pair in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

The first column in Table 5 regresses Jaccard similarity against a dummy equal to one for the post-standard continuations. In the second column, we add pair fixed effects to control for all common characteristics of the pre- and post-standard applications in a pair. In the third column, we control for several observable application characteristics (independent claims, words per independent claim, art-unit-by-examiner effects and filing-year effects), which reduces the sample size because of missing data. All three models confirm that the claims of post-standard continuations are more similar than those of their pre-standard parents. Although it is difficult to interpret the magnitude of this finding, we take the convergence in claim language as further evidence that SEP owners use continuations to draft claims that cover standards.

6 Conclusion

We study the strategic use of continuations to patent technologies developed after the original filing date of a patent. Although continuations have featured prominently in patent policy debates, empirical evidence of this behavior was limited due to measurement challenges. We exploit the disclosure of SEPs during the ICT standardization process to link patents with standards, and to measure the association between the resolution of uncertainty on standard design and the use of continuations. Consistent with the idea that companies use continuations to cover standards after consensus forms around a specific design, we find that a large share of SEPs are continuations filed after standard publication, and that there is a large increase in the continuations of SEPs immediately after a standard is published. We also show that claims in continuations filed post-standard are more likely to receive non-statutory double patenting rejections than those in other continuations, and are more similar to each other than the claims of their pre-standard parent applications.

From a patent policy perspective, continuations present a complex tradeoff. The option to abandon some claims and refine others is especially valuable to applicants facing high levels of uncertainty, such as startups or inventors of very novel technologies. On the other hand, continuations are problematic because they increase uncertainty about the actual scope of patent protection. Unexpected changes in patent scope increase the likelihood of inadvertent infringement, reduce incentives to invent around patents, and create a hold-up threat that can increase the costs of technology adoption.

The USPTO could address the downsides of continuation practice by increasing fees, restricting the use of lengthy continuation "chains" (e.g. by capping the number of links), or by creating intervening-user rights that reduce incentives for opportunistic claiming. With respect to SEPs, SSOs could adopt similar rules as part of their intellectual property policies. It is not easy, however, to predict the behavior of patentees and standards developers under these counterfactual policies. Without continuations, we might see more vague claims, or a surge in last-minute applications filed just before standards are finalized. On the other hand, if patent scope were more predictable, standards developers would have stronger incentives to consider infringement when making design decisions instead of (as some observers claim) leaving the entire problem for patent litigation lawyers to sort out *ex post*.

A full accounting of the costs and benefits of continuation lies beyond the scope of this paper, and presents an interesting topic for future research. Moreover, it is important to recognize that continuations are not the only way to delay claim drafting and issuance. U.S. applicants can use other tools, such as provisional applications or requests for continued examination. In jurisdictions where continuations are not available, applicants can use divisionals or deferred examination. Further research might study how inventors use all of these tools, individually and in combination, to manage the tradeoff between filing early to obtain priority and delaying in order to draft stronger claims.

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Appendix

This Appendix reports a number of supplemental results and robustness checks. The following discussion provides further details regarding estimation of the robustness checks described in Section 4.6 of the paper, with results presented below in Tables A2 through A11.

In Table A2, we consider an alternative sample. Instead of defining SEPs to include all U.S. family members (i.e. applications sharing a common priority) of any patent declared to an SSO, we limit the definition of SEP to include *only* patents or patent applications explicitly mentioned in a disclosure letter to an SSO. Our main results also keep applications in the sample until the last member of their U.S. patent family is pending, so applications with more children are at risk of continuation for longer. In the robustness check, we use only the focal application's pendency at the patent office to define the time at risk of continuations, discarding the pendency of its children. Similarly, we use only the pendency of the earliest filing of each non-SEP patent family for the control group. In this alternative sample, the coefficients on $PostStandard_{it} \times SEP_i$ are similar to those in our main results.

In Table A3, we re-estimate the main DID models using information on all types of child applications, i.e. including also continuations-in-part, divisionals and reissues. In general, these applications also provide opportunities for strategic behavior, although they are used less frequently, in different ways or do not protect exactly the same invention claimed in the original filing. Continuations-in-part also disclose new subject matter and therefore may be related to technological improvements upon the original application, so they may be less related to opportunistic behavior. Although in some cases divisionals are filed voluntarily by the applicant in ways similar to continuations, they are usually filed when an application discloses more than one invention, so the examiner notifies the applicant that she must elect one of the inventions for the prosecution of the original filing and use divisionals to protect the other inventions. Reissue applications, which correct defects in issued patents, are relatively rare, require the surrender of the original patent, and can be used to broaden the scope of the claims only if filed within two years from the grant date of the original patent. Nevertheless, we find similar results when we use also information for these other types of child applications for the analysis.

In Table A4, we control for a number of observable application characteristics that may be related to SEP status and to the propensity to file continuations. Continuations are a relatively rare outcome, so the application fixed effects and matching on pre-standard continuations may not capture well differences among applications in terms of value or prosecution strategies. In order to address this concern at least partially, we re-estimate the cross-sectional models in the main analysis and the previous robustness checks adding to the specifications control variables for the scope of the application (number of independent claims and average length of the independent claims), number of inventors (which is correlated with invention quality (Wuchty, Jones & Uzzi 2007)), dummies for applications that claim priority to provisional and PCT applications (which should partially capture investments in prosecution prior to the filing date of the focal application), as well as dummies for applications filed by small entities and those that claim priority to foreign applications (to control for the type of applicant).[39] Table A4 shows that the results for these models are similar to those reported previously.

In Tables A5, instead of matching on pre-standard trends, we control for the anticipation effects of standard publication. Specifically, we include in our regressions four leads of an indicator equal to one for the SEPs in the quarter of standard publication. Under the assumption that standard publication is exogenous, these leads capture the anticipation effects (Malani & Reif 2015). The results show that, while there are relatively large anticipation effects in the quarter before standard publication, the coefficients on $PostStandard_{it} \times SEP_i$ are similar to those in our main analysis.

Tables A6–A8 consider an alternative specification based on a piecewise constant hazard model, using samples similar to those for the main analysis and for the previous robustness checks. In these regressions, the outcome is the probability of continuation conditional on not having any prior continuations, and an application is removed from the sample after the first period in which any continuation is filed. We also repeat this exercise using information on all child applications.[40] In all models (Tables A6–A8), SEPs have a higher baseline hazard of continuation or child application, and standard publication has a positive and large correlation with the probability of filing the first continuation or the first child application.

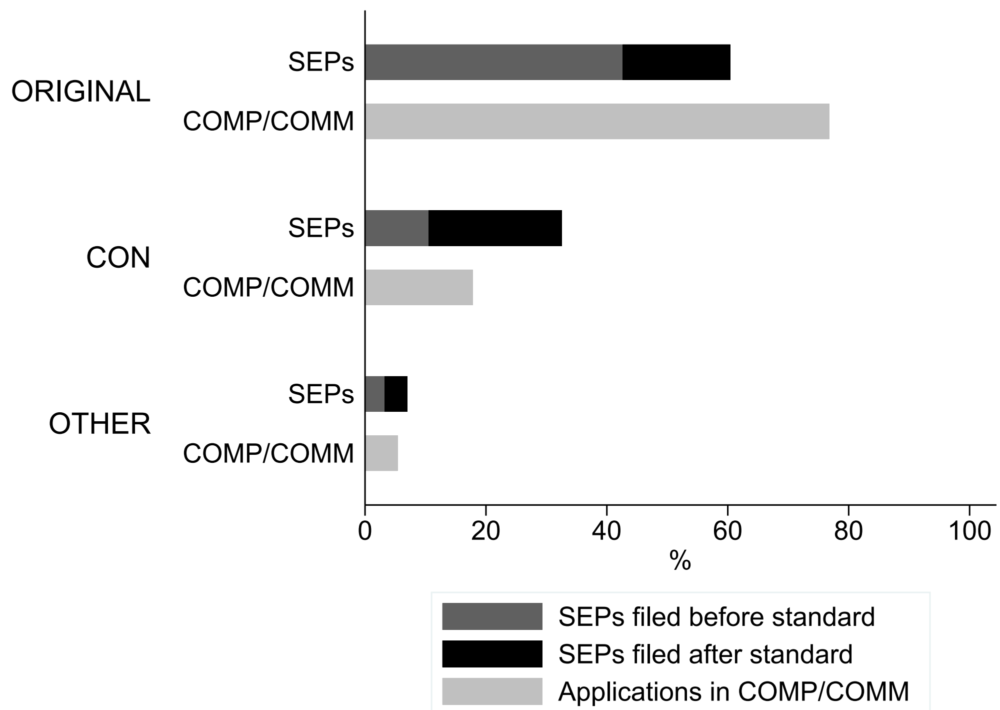
Finally, Tables A9 through A11 provide results based on models similar to those in the main analysis and in the previous robustness checks using samples that contain only SEPs filed before standard publication. That is, we discard the control group and estimate models that are identified based on variation in the timing of standard publication within the SEP sample. The coefficients of $PostStandard_{it}$ are smaller in magnitude and sometimes estimated less precisely than those in the rest of the analysis. Nevertheless, standard publication is associated with an increase in continuation filings statistically significant at conventional

[39]The USPTO defines as small entities independent inventors, companies with less than 500 employees and nonprofit organizations. These applicants have substantial discounts on various USPTO fees.

[40]The samples for Table A6 and Table A8 are constructed using the definition of SEP used in the main analysis, and contains all SEPs filed before the quarter of standard publication and controls in the same art-unit-examiner-filing-quarter group of the SEPs. We keep applications in the sample until the earliest of (i) the filing of the first continuation (Table A6) or child application (Table A8), (ii) family disposal, or (iii) the end of year 2016. The sample for Table A7 is similar but, as in Table A2, uses the narrower definition of SEP and information on standards and pendency of the earliest application in each family.

levels in all but two of these specifications. The results for the models of child application are similar but the coefficients are generally smaller and estimated less precisely. This may be due simply to the lower opportunities for strategic use of continuations-in-part, divisionals and reissues.

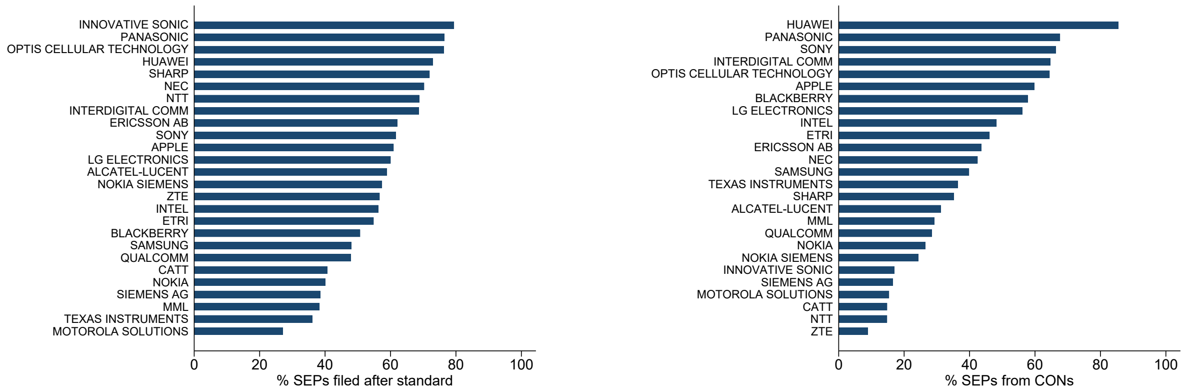
Figure A1: Frequency and timing of SEP continuations, narrower definition of SEP



Notes. The sample contains utility patent applications filed on or after November 29, 2000. Percentages based on 15,695 SEPs and 1,447,286 (non-SEP) applications processed by Technology Centers 2100, 2400 and 2600. SEPs include U.S. utility patent applications declared essential for a standard. Pre- and post-standard SEPs defined using the earliest standard linked to a SEP. Non-SEP applications are U.S. utility patent applications that are not in the patent family of a declared SEP.

Figure A2: Owners of SEPs (declared SEPs and their family members)

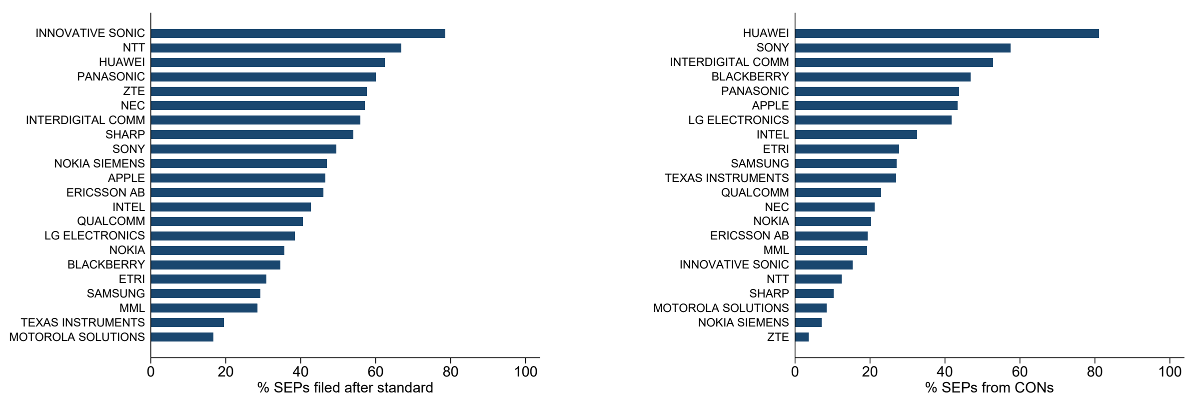
(a) SEPs filed after standard (b) SEPs filed as CONs



Notes. The figure reports the percentage of SEPs owned by each company that are filed after standard publication (panel a) or that are filed as continuations (panel b). The sample contains utility patent applications filed on or after November 29, 2000. SEPs include U.S. utility patent applications declared essential for a standard, as well as all their parent and child applications. Pre- and post-standard SEPs defined using the earliest standard linked to a family of SEPs. The figure reports only companies with at least 100 SEPs.

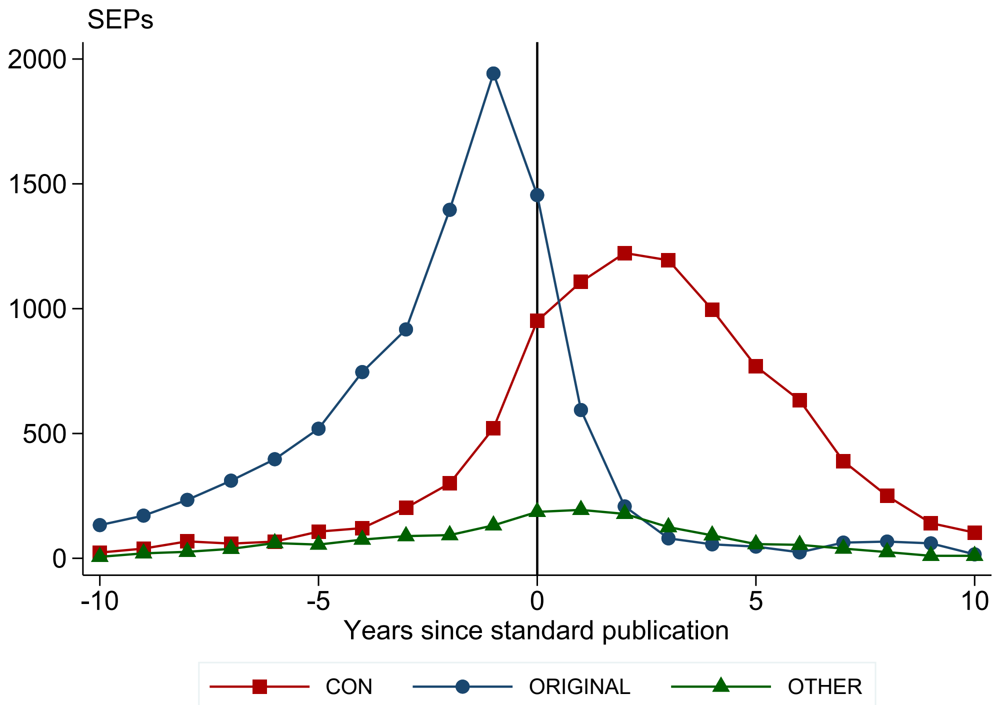
Figure A3: Owners of SEPs (only declared SEPs)

(a) SEPs filed after standard (b) SEPs filed as CONs



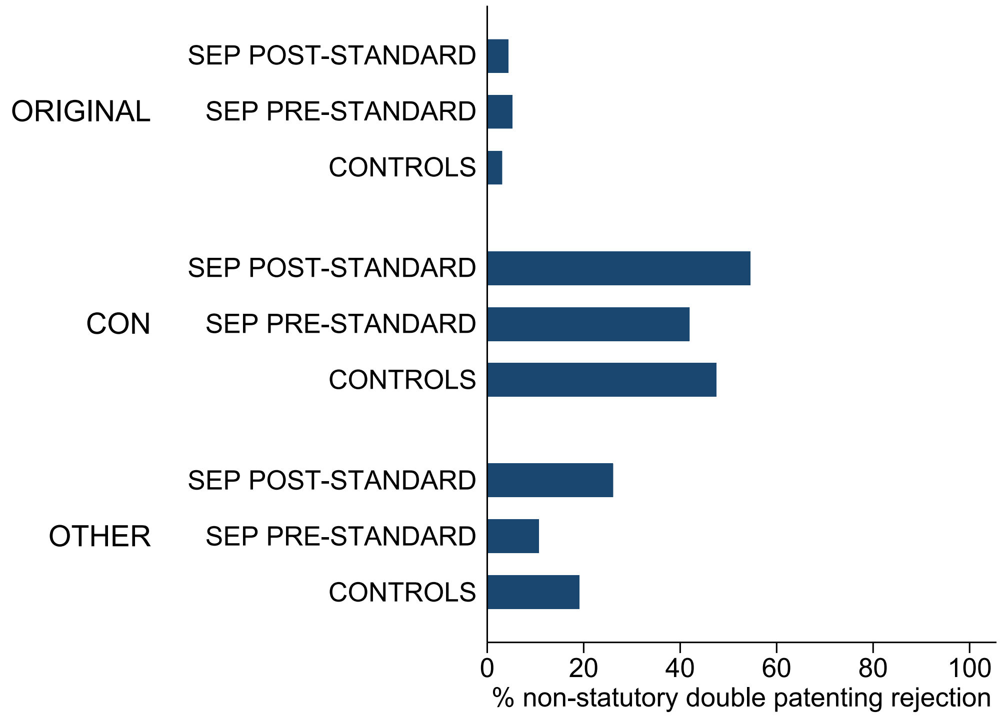
Notes. The figure reports the percentage of SEPs owned by each company that are filed after standard publication (panel a) or that are filed as continuations (panel b). The sample contains utility patent applications filed on or after November 29, 2000. SEPs include U.S. utility patent applications declared essential for a standard. Pre- and post-standard SEPs defined using the earliest standard linked to a SEPs. The figure reports only companies with at least 100 SEPs.

Figure A4: Frequency and timing of SEP continuations, years since standard publication



Notes. The sample contains 21,199 SEPs filed on or after November 29, 2000. SEPs include U.S. utility patent applications declared essential for a standard, as well as all their parent and child applications. For each type of application, we plot the number of SEPs by year since standard publication, where year bins are based on the difference between the application filing month-year and the publication month-year of the earliest standard linked to a family of SEPs. We plot the data for a 21-year window centered around standard publication. This time window contains about 96% of the SEPs in our sample.

Figure A5: Non-statutory double patenting rejections



Notes. The sample contains 22,204 utility patent applications filed after year 2007 and disposed before July 2017. We match SEPs and non-SEPs ("controls") on art unit, examiner, filing year and type of application (CON, original or the residual category "other"). SEPs include U.S. utility patent applications declared essential for a standard. Pre- and post-standard SEPs defined using the earliest standard linked to a SEP. Non-SEP applications are U.S. utility patent applications that are not in the patent family of a declared SEP. We match one-to-one, without replacement and breaking ties at random, matching 94% of the SEPs in the sample period with information on the standard publication date. The final sample contains 10,588 CONs (4,548 post-standard SEPs, 746 pre-standard SEPs and 5,294 controls), 10,476 original applications (1,765 post-standard SEPs, 3,473 pre-standard SEPs and 5,238 controls), and 1,140 applications in the residual category "other" (402 post-standard SEPs, 168 pre-standard SEPs and 570 controls).

Table A1: Summary statistics for SEPs and controls in the main analysis sample

	N	Mean	SD	Min	1^{st} Q	Median	3^{rd} Q	Max
CON	959,733	0.012	0.110	0.000	0.000	0.000	0.000	1.000
CONs	959,733	0.013	0.166	0.000	0.000	0.000	0.000	98.000
PostStandard × SEP	959,733	0.086	0.281	0.000	0.000	0.000	0.000	1.000
SEP	959,733	0.137	0.343	0.000	0.000	0.000	0.000	1.000
Age	959,733	10.425	8.580	0.000	4.000	9.000	15.000	64.000
Ind. claims	884,347	3.937	2.879	0.000	2.000	3.000	4.000	76.000
Words per ind. claim	883,852	115.338	85.697	7.000	75.833	101.200	136.500	4,535.000
Inventors	959,733	2.722	1.706	1.000	1.000	2.000	4.000	22.000
Provisional	959,733	0.263	0.440	0.000	0.000	0.000	1.000	1.000
PCT	959,733	0.197	0.398	0.000	0.000	0.000	0.000	1.000
Small entity	959,733	0.097	0.296	0.000	0.000	0.000	0.000	1.000
Foreign priority	959,733	0.352	0.477	0.000	0.000	0.000	1.000	1.000
Leniency (ind. claims)*	942,154	-0.236	0.378	-7.615	-0.400	-0.200	-0.023	1.179
Leniency (grant rate)**	959,627	0.749	0.134	0.026	0.682	0.780	0.850	1.000

Notes. The unit of observation is an application-quarter. An application is included in the sample from its filing quarter to the latest disposal quarter of an application in its U.S. patent family, or the end of year 2016 if its family is still pending (i.e. at least one filing in the U.S. patent family is still under examination). A SEP is the earliest U.S. utility patent application of a domestic patent family that contains at least one U.S. utility patent application declared essential for a standard. A control application is the earliest U.S. utility patent application of a domestic patent family that does not contain any U.S. utility patent applications declared essential for a standard. The sample contains SEPs whose family is still pending in the quarter of publication of the earliest standard linked to the family and control applications in art-unit-examiner-filing-quarter groups with at least one SEP and one control. The sample contains 53,112 applications (5,487 SEPs and 47,625 controls). *Statistics reported for the sample in Table 2. **Statistics reported for the sample in Table A12.

Table A2: Difference in differences models of continuation filing, declared SEPs and controls

Outcome	CON × 100					
Specification	OLS					
Sample	SEPs and controls			SEPs and controls matched on pre-standard CONs		
Model	pooled cross-section	tech & cohort	FE	pooled cross-section	tech & cohort	FE
	(1)	(2)	(3)	(4)	(5)	(6)
PostStandard × SEP	1.73***	1.66***	2.09***	1.76***	1.79***	2.30***
	(0.08)	(0.08)	(0.12)	(0.09)	(0.10)	(0.14)
SEP	-0.01	0.11***		-0.00	-0.00	
	(0.03)	(0.04)		(0.02)	(0.04)	
Quarter FE	✓	✓	✓	✓	✓	✓
Age FE	✓			✓		
AU-E-FQ FE		✓			✓	
Age^2, age^3 & age^4		✓	✓		✓	✓
Application FE			✓			✓
PostStandard				✓	✓	✓
Observations	758,930	758,930	758,930	168,858	168,858	168,858
R-squared	0.01	0.02	0.08	0.02	0.05	0.08
Applications	46,919	46,919	4,6919	9,442	9,442	9,442
Mean of outcome	0.90	0.90	0.90	1.33	1.33	1.33

Notes. The unit of observation is an application-quarter. An application is included in the sample from its filing quarter to the quarter of disposal or the end of year 2016 if still pending. A SEP is the earliest U.S. utility patent application of a domestic patent family that contains at least one U.S. utility patent application declared essential for a standard. A control application is the earliest U.S. utility patent application of a domestic patent family that does not contain any U.S. utility patent applications declared essential for a standard. The sample for models (1)-(3) contains SEPs that are mentioned in patent disclosure letters and are pending in the quarter of publication of the earliest standard linked to the application, and control applications in art-unit-examiner-filing-quarter groups with at least one SEP and one control. The sample for models (4)-(6) contains SEPs that are mentioned in patent disclosure letters and are pending in the quarter of publication of the earliest standard linked to the application, and controls pending in the quarter before standard publication matched on filing quarter, art unit, examiner and cumulative number of continuations in the quarter before standard publication. Standard errors clustered by application in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table A3: Difference in differences models of child application filing

Outcome	Child × 100					
Specification	OLS					
Sample	SEPs and controls			SEPs and controls matched on pre-standard CONs		
Model	pooled cross-section	tech & cohort	FE	pooled cross-section	tech & cohort	FE
	(1)	(2)	(3)	(4)	(5)	(6)
PostStandard × SEP	0.87***	0.68***	1.67***	2.03***	1.91***	2.22***
	(0.11)	(0.10)	(0.11)	(0.12)	(0.10)	(0.13)
SEP	1.14***	1.31***		-0.01	-0.01	
	(0.08)	(0.07)		(0.06)	(0.05)	
Quarter FE	✓	✓	✓	✓	✓	✓
Age FE	✓			✓		
AU-E-FQ FE		✓			✓	
Age^2, age^3 & age^4		✓	✓		✓	✓
Application FE			✓			✓
PostStandard				✓	✓	✓
Observations	959,733	959,733	959,733	206,464	206,464	206,464
R-squared	0.02	0.03	0.07	0.02	0.05	0.07
Applications	53,112	53,112	53,112	9,862	9,862	9,862
Mean of outcome	1.72	1.72	1.72	2.46	2.46	2.46

Notes. The unit of observation is an application-quarter. An application is included in the sample from its filing quarter to the latest disposal quarter of an application in its U.S. patent family, or the end of year 2016 if its family is still pending (i.e. at least one filing in the U.S. patent family is still under examination). A SEP is the earliest U.S. utility patent application of a domestic patent family that contains at least one U.S. utility patent application declared essential for a standard. A control application is the earliest U.S. utility patent application of a domestic patent family that does not contain any U.S. utility patent applications declared essential for a standard. The sample for models (1)-(3) contains SEPs whose family is pending at standard publication and control applications in art-unit-examiner-filing-quarter groups with at least one SEP and one control. The sample for models (4)-(6) contains SEPs whose family is still pending at standard publication and control applications whose family is still pending in the quarter before standard publication matched on filing quarter, art unit, examiner and cumulative number of child applications in the quarter before standard publication. The quarter of standard publication is the quarter of publication of the earliest standard linked to a family of SEPs. Standard errors clustered by application in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A4: Difference in differences models controlling for application characteristics

Specification	OLS											
Outcome	CON × 100								Child × 100			
Sample	Info on entire family, all		Info on entire family, matched on pre-trend		Info on first application in family, all		Info on first application in family, matched on pre-trend		Info on entire family, all		Info on the entire family, matched on pre-trend	
Model	pooled cross-section	tech cohort	pooled cross-section	tech cohort	pooled cross-section	tech cohort	pooled cross-section	tech cohort	pooled cross-section	tech cohort	pooled cross-section	tech cohort
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
PostStandard × SEP	1.22***	1.07***	2.11***	1.99***	1.78***	1.73***	1.85***	1.89***	1.01***	0.83***	2.17***	2.04***
	(0.09)	(0.09)	(0.11)	(0.09)	(0.08)	(0.08)	(0.10)	(0.10)	(0.11)	(0.10)	(0.12)	(0.10)
SEP	0.79***	0.89***	-0.01	0.05	0.02	0.13***	0.05	0.08	1.05***	1.21***	-0.02	0.01
	(0.05)	(0.05)	(0.05)	(0.05)	(0.03)	(0.04)	(0.03)	(0.05)	(0.08)	(0.07)	(0.06)	(0.06)
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Age FE	✓		✓		✓		✓		✓		✓	
AU-E-FQ FE		✓		✓		✓		✓		✓		✓
Age^2, age^3 & age^4		✓		✓		✓		✓		✓		✓
Observations	865,911	865,911	190,490	190,490	691,645	691,645	153,004	153,004	865,911	865,911	185,547	185,547
R-squared	0.02	0.03	0.02	0.05	0.01	0.02	0.02	0.05	0.02	0.03	0.03	0.05
Applications	47,730	47,730	9,058	9,058	42,416	42,416	8,530	8,530	47,730	47,730	8,866	8,866
Mean of outcome	1.19	1.19	1.87	1.87	0.88	0.88	1.30	1.30	1.69	1.69	2.41	2.41

Notes. The unit of observation is an application-quarter. Models (1)-(4) estimated on the samples for Table 1. Models (5)-(8) estimated on the samples for Table A2. Models (9)-(12) estimated on the samples for Table A3. All models include control variables for the characteristics of the earliest U.S. utility patent application of a family. These include indicators for applications that claim priority to provisional applications, PCT applications or foreign applications, an indicator for applications filed by small entities, and the natural logarithms of the number of independent claims, the number of words per independent claim, and the number of inventors. Models in odd columns estimated after dropping applications with missing values for the control variables and keeping only examiner-art-unit-filing-quarter groups with at least one SEP and one control. Models in even columns estimated keeping only matched pairs with complete information for the control variables for both applications. Standard errors clustered by application in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table A5: Difference in differences models, anticipation

Outcome	CON × 100								Child × 100			
Sample	Info on entire family				Info on first application in family				Info on entire family			
Model	pooled cross-section	tech & cohort	controls	FE	pooled cross-section	tech & cohort	controls	FE	pooled cross-section	tech & cohort	controls	FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
PostStandard × SEP	1.17***	1.05***	1.18***	1.99***	1.74***	1.64***	1.73***	2.08***	0.84***	0.66***	0.86***	2.26***
	(0.10)	(0.09)	(0.09)	(0.12)	(0.08)	(0.08)	(0.09)	(0.15)	(0.13)	(0.13)	(0.12)	(0.15)
Standard $(t-1)$ × SEP	0.57***	0.59***	0.62***	1.28***	0.67***	0.60***	0.57***	0.60***	0.22	0.19	0.24	1.38***
	(0.19)	(0.19)	(0.19)	(0.21)	(0.15)	(0.15)	(0.15)	(0.18)	(0.22)	(0.22)	(0.22)	(0.23)
Standard $(t-2)$ × SEP	0.23	0.25	0.31*	0.92***	-0.07	-0.13	-0.09	-0.10	-0.03	-0.07	0.07	1.07***
	(0.18)	(0.18)	(0.18)	(0.20)	(0.08)	(0.09)	(0.09)	(0.12)	(0.22)	(0.22)	(0.23)	(0.23)
Standard $(t-3)$ × SEP	0.23	0.26	0.34*	0.88***	-0.06	-0.12	-0.12	-0.10	-0.00	-0.03	0.09	1.02***
	(0.19)	(0.19)	(0.19)	(0.20)	(0.08)	(0.09)	(0.09)	(0.11)	(0.23)	(0.23)	(0.23)	(0.24)
Standard $(t-4)$ × SEP	0.28	0.30	0.29	0.85***	-0.16**	-0.22***	-0.21***	-0.22**	0.31	0.27	0.26	1.22***
	(0.19)	(0.19)	(0.19)	(0.21)	(0.06)	(0.07)	(0.07)	(0.09)	(0.25)	(0.25)	(0.25)	(0.26)
SEP	0.66***	0.75***	0.71***		-0.07***	0.08**	0.09**		1.08***	1.27***	1.13***	
	(0.06)	(0.06)	(0.06)		(0.03)	(0.04)	(0.04)		(0.10)	(0.10)	(0.10)	
Quarter FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Age FE	✓				✓				✓			
AU-E-FQ FE		✓	✓			✓	✓			✓	✓	
Age^2, age^3 & age^4		✓	✓	✓		✓	✓	✓		✓	✓	✓
Controls			✓				✓				✓	
Application FE				✓				✓				✓
Observations	927,567	927,567	838,603	927,567	742,204	742,204	678,532	742,204	927,567	927,567	838,603	927,567
R-squared	0.02	0.03	0.03	0.07	0.01	0.02	0.02	0.08	0.02	0.03	0.03	0.07
Applications	53,112	53,112	47,730	53,112	46,919	46,919	42,416	46,919	53,112	53,112	47,730	53,112
Mean of outcome	1.12	1.12	1.09	1.12	0.85	0.85	0.82	0.85	1.60	1.60	1.56	1.60

Notes. The unit of observation is an application-quarter. Models (1)-(4) estimated on the samples for Table 1. Models (5)-(8) estimated on the samples for Table A2. Models (9)-(12) estimated on the samples for Table A3. Control variables for the characteristics of the earliest U.S. utility patent application of a family include indicators for applications that claim priority to provisional applications, PCT applications or foreign applications, an indicator for applications filed by small entities, and the natural logarithms of the number of independent claims, the number of words per independent claim, and the number of inventors. Models (3), (7) and (11) estimated after dropping applications with missing values for the control variables and keeping only examiner-art-unit-filing-quarter groups with at least one SEP and one control. Standard errors clustered by application in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table A6: Hazard models of continuation filing

Outcome	CON × 100					
Specification	OLS					
Models	Myopic			Quasi-myopic		
Model	pooled cross-section (1)	tech & cohort (2)	controls (3)	pooled cross-section (4)	tech & cohort (5)	controls (6)
PostStandard × SEP	1.02***	1.09***	1.15***	1.11***	1.20***	1.27***
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Standard $(t-1)$ × SEP				0.66***	0.74***	0.70***
				(0.17)	(0.17)	(0.17)
Standard $(t-2)$ × SEP				0.47***	0.54***	0.55***
				(0.17)	(0.17)	(0.17)
Standard $(t-3)$ × SEP				0.35**	0.42**	0.44**
				(0.17)	(0.17)	(0.17)
Standard $(t-4)$ × SEP				0.15	0.19	0.18
				(0.16)	(0.16)	(0.16)
SEP	0.49***	0.53***	0.54***	0.36***	0.38***	0.39***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Quarter FE	✓	✓	✓	✓	✓	✓
Age FE	✓			✓		
AU-E-FQ FE		✓	✓		✓	✓
Age^2, age^3 & age^4		✓	✓		✓	✓
Controls			✓			✓
Observations	1,071,574	1,071,574	959,984	1,052,185	1,052,186	944,361
R-squared	0.01	0.02	0.02	0.01	0.02	0.02
Applications	65,486	65,486	58,261	65,486	65,486	58,261
Mean of outcome	0.81	0.81	0.79	0.78	0.78	0.75

Notes. The unit of observation is an application-quarter. An application is included in the sample from its filing quarter to the earliest of the filing quarter of its first continuation, the latest disposal quarter of an application in its U.S. patent family or the end of year 2016 if its family is still pending (i.e. at least one filing in the U.S. patent family is still under examination). A SEP is the earliest U.S. utility patent application of a domestic patent family that contains at least one U.S. utility patent application declared essential for a standard. A control application is the earliest U.S. utility patent application of a domestic patent family that does not contain any U.S. utility patent applications declared essential for a standard. The sample contains SEPs filed before the quarter of publication of the earliest standard linked to their family and control applications in art-unit-examiner-filing-quarter groups with at least one SEP and one control. Control variables for the characteristics of the earliest U.S. utility patent application of a family include indicators for applications that claim priority to provisional applications, PCT applications or foreign applications, an indicator for applications filed by small entities, and the natural logarithms of the number of independent claims, the number of words per independent claim, and the number of inventors. Models (3) and (6) estimated after dropping applications with missing values for the control variables and keeping only examiner-art-unit-filing-quarter groups with at least one SEP and one control. Standard errors clustered by application in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A7: Hazard models of continuation filing, declared SEPs and controls

Outcome	CON × 100					
Specification	OLS					
Models	Myopic			Quasi-myopic		
Model	pooled cross-section	tech & cohort	controls	pooled cross-section	tech & cohort	controls
	(1)	(2)	(3)	(4)	(5)	(6)
PostStandard × SEP	1.17***	1.24***	1.29***	1.23***	1.33***	1.40***
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.09)
Standard $(t-1)$ × SEP				0.77***	0.86***	0.82***
				(0.18)	(0.18)	(0.18)
Standard $(t-2)$ × SEP				0.34**	0.42***	0.47***
				(0.16)	(0.16)	(0.17)
Standard $(t-3)$ × SEP				0.32*	0.39**	0.38**
				(0.16)	(0.17)	(0.17)
Standard $(t-4)$ × SEP				0.11	0.15	0.17
				(0.15)	(0.15)	(0.16)
SEP	0.44***	0.50***	0.52***	0.32***	0.35***	0.36***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Quarter FE	✓	✓	✓	✓	✓	✓
Age FE	✓			✓		
AU-E-FQ FE		✓	✓		✓	✓
Age^2, age^3 & age^4		✓	✓		✓	✓
Controls			✓			✓
Observations	1,004,990	1,004,995	904,014	988,569	988,570	891,139
R-squared	0.01	0.02	0.02	0.01	0.02	0.02
Applications	63,158	63,158	56,386	63,158	63,158	56,386
Mean of outcome	0.83	0.83	0.81	0.79	0.79	0.77

Notes. The unit of observation is an application-quarter. An application is included in the sample from its filing quarter to the earliest of the filing quarter of its first continuation, the quarter of disposal or the end of year 2016 if it is still pending. A SEP is the earliest U.S. utility patent application of a domestic patent family that contains at least one U.S. utility patent application declared essential for a standard. A control application is the earliest U.S. utility patent application of a domestic patent family that does not contain any U.S. utility patent applications declared essential for a standard. The sample contains SEPs that are mentioned in patent disclosure letters and are filed before the quarter of publication of the earliest standard linked to the application, and control applications in art-unit-examiner-filing-quarter groups with at least one SEP and one control. Control variables for the characteristics of the earliest U.S. utility patent application of a family include indicators for applications that claim priority to provisional applications, PCT applications or foreign applications, an indicator for applications filed by small entities, and the natural logarithms of the number of independent claims, the number of words per independent claim, and the number of inventors. Models (3) and (6) estimated after dropping applications with missing values for the control variables and keeping only examiner-art-unit-filing-quarter groups with at least one SEP and one control. Standard errors clustered by application in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A8: Hazard models of child application filing

Outcome	Child × 100					
Specification	OLS					
Models	Myopic			Quasi-myopic		
Model	pooled cross-section (1)	tech & cohort (2)	controls (3)	pooled cross-section (4)	tech & cohort (5)	controls (6)
PostStandard × SEP	1.14***	1.20***	1.25***	1.17***	1.26***	1.32***
	(0.09)	(0.09)	(0.09)	(0.10)	(0.10)	(0.10)
Standard $(t-1)$ × SEP				0.56***	0.63***	0.59***
				(0.20)	(0.20)	(0.20)
Standard $(t-2)$ × SEP				0.40**	0.45**	0.48**
				(0.20)	(0.20)	(0.20)
Standard $(t-3)$ × SEP				0.21	0.25	0.28
				(0.19)	(0.20)	(0.20)
Standard $(t-4)$ × SEP				0.17	0.19	0.16
				(0.20)	(0.20)	(0.20)
SEP	0.67***	0.80***	0.76***	0.57***	0.68***	0.63***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)
Quarter FE	✓	✓	✓	✓	✓	✓
Age FE	✓			✓		
AU-E-FQ FE		✓	✓		✓	✓
Age^2, age^3 & age^4		✓	✓		✓	✓
Controls			✓			✓
Observations	1,017,784	1,017,788	913,169	1,001,621	1,001,621	900,503
R-squared	0.01	0.02	0.02	0.01	0.02	0.02
Applications	65,486	65,486	58,261	65,486	65,486	58,261
Mean of outcome	1.21	1.21	1.18	1.17	1.17	1.13

Notes. The unit of observation is an application-quarter. An application is included in the sample from its filing quarter to the earliest of the filing quarter of its first continuation, the latest disposal quarter of an application in its U.S. patent family or the end of year 2016 if its family is still pending (i.e. at least one filing in the U.S. patent family is still under examination). A SEP is the earliest U.S. utility patent application of a domestic patent family that contains at least one U.S. utility patent application declared essential for a standard. A control application is the earliest U.S. utility patent application of a domestic patent family that does not contain any U.S. utility patent applications declared essential for a standard. The sample contains SEPs filed before the quarter of publication of the earliest standard linked to their family and control applications in art-unit-examiner-filing-quarter groups with at least one SEP and one control. Control variables for the characteristics of the earliest U.S. utility patent application of a family include indicators for applications that claim priority to provisional applications, PCT applications or foreign applications, an indicator for applications filed by small entities, and the natural logarithms of the number of independent claims, the number of words per independent claim, and the number of inventors. Models (3) and (6) estimated after dropping applications with missing values for the control variables and keeping only examiner-art-unit-filing-quarter groups with at least one SEP and one control. Standard errors clustered by application in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A9: Difference in differences and hazard models of continuation filing, only SEPs

Outcome	CON × 100													
	DID, myopic				DID, quasi-myopic				Hazard, myopic			Hazard, quasi-myopic		
Model	cross-section (1)	tech cohort (2)	controls (3)	FE (4)	cross-section (5)	tech cohort (6)	controls (7)	FE (8)	cross-section (9)	tech cohort (10)	controls (11)	cross-section (12)	tech cohort (13)	controls (14)
PostStandard	0.26***	0.20*	0.19	0.19	0.33***	0.47***	0.47***	0.52***	0.15*	0.39***	0.39***	0.21**	0.67***	0.67***
	(0.10)	(0.12)	(0.12)	(0.12)	(0.10)	(0.15)	(0.15)	(0.16)	(0.09)	(0.13)	(0.13)	(0.09)	(0.17)	(0.17)
Standard $(t-1)$					0.39**	0.58***	0.58***	0.61***				0.31*	0.54***	0.53**
					(0.18)	(0.20)	(0.20)	(0.21)				(0.17)	(0.20)	(0.21)
Standard $(t-2)$					0.07	0.27	0.30	0.31				0.20	0.45**	0.44**
					(0.17)	(0.19)	(0.19)	(0.19)				(0.17)	(0.20)	(0.20)
Standard $(t-3)$					0.17	0.38**	0.39**	0.42**				0.20	0.43**	0.43**
					(0.17)	(0.20)	(0.20)	(0.20)				(0.17)	(0.19)	(0.19)
Standard $(t-4)$					0.18	0.36*	0.33*	0.41**				-0.03	0.14	0.13
					(0.18)	(0.19)	(0.19)	(0.19)				(0.16)	(0.17)	(0.17)
Quarter FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Age FE	✓				✓				✓			✓		
AU-E-FQ FE		✓	✓			✓	✓			✓	✓		✓	✓
Age^2, age^3 & age^4		✓	✓	✓		✓	✓	✓		✓	✓		✓	✓
Controls			✓				✓				✓			✓
Application FE				✓				✓						
Observations	162,126	161,936	156,927	162,126	153,354	153,168	148,379	153,354	131,348	131,211	127,289	128,008	127,872	124,069
R-squared	0.02	0.06	0.06	0.07	0.02	0.06	0.06	0.07	0.02	0.08	0.08	0.02	0.08	0.08
Applications	7,019	7,012	6,798	7,019	7,019	7,012	6,798	7,019	7,019	7,003	6,791	7,019	7,003	6,791
Mean of outcome	2.67	2.67	2.67	2.67	2.44	2.44	2.44	2.44	1.80	1.80	1.80	1.73	1.72	1.72

Notes. The unit of observation is an application-quarter. An application is included in the sample from its filing quarter to the latest disposal quarter of an application in its U.S. patent family, or the end of year 2016 if its family is still pending (i.e. at least one filing in the U.S. patent family is still under examination) in columns (1)-(8), and to the earliest of the filing quarter of its first continuation, the latest disposal quarter of an application in its U.S. patent family or the end of year 2016 if its family is still pending in columns (9)-(14). A SEP is the earliest U.S. utility patent application of a domestic patent family that contains at least one U.S. utility patent application declared essential for a standard. The sample contains SEPs filed before the quarter of publication of the earliest standard linked to their family. Control variables for the characteristics of the earliest U.S. utility patent application of a family include indicators for applications that claim priority to provisional applications, PCT applications or foreign applications, an indicator for applications filed by small entities, and the natural logarithms of the number of independent claims, the number of words per independent claim, and the number of inventors. Standard errors clustered by application in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A10: Difference in differences and hazard models of continuation filing, only declared SEPs

Outcome	CON × 100													
	DID, myopic				DID, quasi-myopic				Hazard, myopic			Hazard, quasi-myopic		
Model	cross-section (1)	tech cohort (2)	controls (3)	FE (4)	cross-section (5)	tech cohort (6)	controls (7)	FE (8)	cross-section (9)	tech cohort (10)	controls (11)	cross-section (12)	tech cohort (13)	controls (14)
PostStandard	0.22**	0.41***	0.40***	0.38***	0.27***	0.72***	0.71***	0.77***	0.15*	0.49***	0.48***	0.19**	0.80***	0.78***
	(0.09)	(0.13)	(0.13)	(0.14)	(0.09)	(0.17)	(0.18)	(0.21)	(0.09)	(0.14)	(0.14)	(0.09)	(0.18)	(0.18)
Standard ($t-1$)					0.37**	0.71***	0.69***	0.74***				0.35**	0.70***	0.69***
					(0.18)	(0.21)	(0.21)	(0.23)				(0.18)	(0.21)	(0.22)
Standard ($t-2$)					0.07	0.39**	0.42**	0.44**				0.02	0.39**	0.41**
					(0.16)	(0.19)	(0.20)	(0.20)				(0.16)	(0.19)	(0.20)
Standard ($t-3$)					0.12	0.40**	0.38*	0.45**				0.12	0.45**	0.41**
					(0.17)	(0.19)	(0.19)	(0.20)				(0.17)	(0.19)	(0.19)
Standard ($t-4$)					-0.07	0.18	0.19	0.22				-0.09	0.16	0.17
					(0.16)	(0.18)	(0.18)	(0.18)				(0.16)	(0.17)	(0.18)
Quarter FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Age FE	✓				✓				✓			✓		
AU-E-FQ FE		✓	✓			✓	✓			✓	✓		✓	✓
Age^2, age^3 & age^4		✓	✓	✓		✓	✓	✓		✓	✓		✓	✓
Controls			✓				✓				✓			✓
Application FE				✓				✓						
Observations	125,427	125,427	122,103	125,427	122,606	122,608	119,392	122,608	121,914	121,907	118,643	119,324	119,319	116,157
R-squared	0.02	0.07	0.07	0.08	0.02	0.08	0.08	0.09	0.02	0.08	0.08	0.02	0.08	0.08
Applications	6,834	6,834	6,638	6,834	6,834	6,834	6,638	6,834	6,834	6,827	6,632	6,834	6,827	6,632
Mean of outcome	1.928	1.93	1.93	1.93	1.84	1.84	1.84	1.84	1.86	1.85	1.85	1.76	1.76	1.76

Notes. The unit of observation is an application-quarter. Applications included in the sample from their filing quarter to the quarter of disposal or the end of year 2016 if still pending in columns (1)-(8), and to the earliest of the filing quarter of their first continuation, the quarter of disposal or the end of year 2016 if censored in columns (9)-(14). A SEP is the earliest U.S. utility patent application of a domestic patent family that contains at least one U.S. utility patent application declared essential for a standard. The sample contains SEPs that are mentioned in patent disclosure letters and are filed before the quarter of publication of the earliest standard linked to the application. Control variables for the characteristics of the earliest U.S. utility patent application of a family include indicators for applications that claim priority to provisional applications, PCT applications or foreign applications, an indicator for applications filed by small entities, and the natural logarithms of the number of independent claims, the number of words per independent claim, and the number of inventors. Standard errors clustered by application in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A11: Difference in differences and hazard models of child application filing, only SEPs

Outcome	Child × 100													
	DID, myopic				DID, quasi-myopic				Hazard, myopic			Hazard, quasi-myopic		
Model	cross-section (1)	tech cohort (2)	controls (3)	FE (4)	cross-section (5)	tech cohort (6)	controls (7)	FE (8)	cross-section (9)	tech cohort (10)	controls (11)	cross-section (12)	tech cohort (13)	controls (14)
PostStandard	0.12	0.20	0.20	0.16	0.16	0.53***	0.54***	0.55***	0.03	0.45***	0.43***	0.07	0.92***	0.88***
	(0.12)	(0.13)	(0.14)	(0.14)	(0.13)	(0.17)	(0.17)	(0.20)	(0.11)	(0.16)	(0.16)	(0.11)	(0.21)	(0.21)
Standard $(t-1)$					0.23	0.58**	0.54**	0.58**				0.21	0.84***	0.80***
					(0.20)	(0.23)	(0.23)	(0.23)				(0.20)	(0.24)	(0.24)
Standard $(t-2)$					0.03	0.38*	0.43*	0.39*				0.13	0.75***	0.73***
					(0.20)	(0.23)	(0.23)	(0.23)				(0.20)	(0.23)	(0.24)
Standard $(t-3)$					0.07	0.40*	0.41*	0.41*				0.04	0.61***	0.59***
					(0.21)	(0.23)	(0.23)	(0.23)				(0.20)	(0.22)	(0.23)
Standard $(t-4)$					0.32	0.55**	0.48**	0.62***				0.02	0.45**	0.41*
					(0.23)	(0.24)	(0.24)	(0.24)				(0.20)	(0.22)	(0.22)
Quarter FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Age FE	✓				✓				✓			✓		
AU-E-FQ FE		✓	✓			✓	✓			✓	✓		✓	✓
Age^2, age^3 & age^4		✓	✓	✓		✓	✓	✓		✓	✓		✓	✓
Controls			✓				✓				✓			✓
Application FE				✓				✓						
Observations	162,126	161,936	156,927	162,126	153,354	153,168	148,379	153,354	121,222	121,179	117,752	118,700	118,657	115,332
R-squared	0.02	0.06	0.06	0.07	0.02	0.06	0.06	0.07	0.02	0.09	0.09	0.02	0.09	0.09
Applications	7,019	7,012	6,798	7,019	7,019	7,012	6,798	7,019	7,019	6,987	6,775	7,019	6,987	6,775
Mean of outcome	3.408	3.40	3.38	3.41	3.17	3.16	3.14	3.17	2.44	2.42	2.41	2.34	2.32	2.32

Notes. The unit of observation is an application-quarter. An application is included in the sample from its filing quarter to the latest disposal quarter of an application in its U.S. patent family, or the end of year 2016 if its family is still pending (i.e. at least one filing in the U.S. patent family is still under examination) in columns (1)-(8), and to the earliest of the filing quarter of its first child application, the latest disposal quarter of an application in its U.S. patent family or the end of year 2016 if its family is still pending in columns (9)-(14). A SEP is the earliest U.S. utility patent application of a domestic patent family that contains at least one U.S. utility patent application declared essential for a standard. The sample contains SEPs filed before the quarter of publication of the earliest standard linked to their family. Control variables for the characteristics of the earliest U.S. utility patent application of a family include indicators for applications that claim priority to provisional applications, PCT applications or foreign applications, an indicator for applications filed by small entities, and the natural logarithms of the number of independent claims, the number of words per independent claim, and the number of inventors. Standard errors clustered by application in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A12: Heterogeneous effects by examiner leniency measured as grant rate

Outcome	CON × 100					
Specification	OLS					
Sample	SEPs and controls			SEPs and controls matched on pre-standard CONs		
Model	pooled cross-section	tech & cohort	FE	pooled cross-section	tech & cohort	FE
	(1)	(2)	(3)	(4)	(5)	(6)
PostStandard × SEP × Leniency (std)	0.92***	0.91***	0.74***	0.87***	0.81***	0.87***
	(0.07)	(0.06)	(0.08)	(0.08)	(0.06)	(0.08)
PostStandard × SEP ×	1.09***	0.98***	1.49***	1.96***	1.87***	1.96***
	(0.09)	(0.08)	(0.09)	(0.10)	(0.09)	(0.11)
SEP	0.82***	0.90***		0.00	0.00	
	(0.05)	(0.05)		(0.04)	(0.04)	
Leniency (std)	0.31***			0.30***		
	(0.01)			(0.03)		
Quarter FE	✓	✓	✓	✓	✓	✓
Age FE	✓			✓		
AU-E-FQ FE		✓			✓	
Age^2, age^3 & age^4		✓	✓		✓	✓
Application FE			✓			✓
PostStandard				✓	✓	✓
Observations	959,627	959,627	959,627	211,281	211,281	211,281
R-squared	0.02	0.03	0.07	0.03	0.05	0.07
Applications	53,106	53,106	53,106	10,052	10,052	10,052
Mean of outcome	1.22	1.22	1.22	1.91	1.91	1.91

Notes. The unit of observation is an application-quarter. See Table 1 for the description of the samples. We keep in the samples the applications whose examiner disposes at least 10 applications outside the focal family that are published before grant, and keep in the sample art-unit-examiner-filing-quarter groups with at least one SEP and one control after this restriction (models (1)-(3)), and matched pairs where both applications meet this additional criterion (models (4)-(6)). Standard errors clustered by application in parentheses. *** p<0.01, ** p<0.05, * p<0.1