An Analysis of the Filing Behavior for Essential Patents in Standards

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Abstract

This article addresses companies' filing behavior for patents relevant for standard setting ("essential patents"). We discuss applicants' incentives to achieve conformity of patent applications with technology standards under development. Based on these incentive structure, we hypothesize that the claims of essential patents are amended more often than comparable patents. Additionally, we argue that applicants have incentives to delay the grant decision. As a result, essential patents are hypothesized to have longer pendency times than comparable patents. This implies more possibilities for applicants to exploit the flexibility within the patent application process to change the claims of pending patent applications. For empiric validation, we use procedural patent data from the European patent application process. We adopt a one-to-one matching approach, pairing essential patents in telecommunication with control patents on the matching criteria of application time, IPC subclass and applicant name. Additionally, we compare these essentials with patents of companies that do not hold standard-relevant patents. We detect higher number of claims and claim amendments as well as other relevant characteristics for the essential patents. Using survival analysis, we show that these patents have significantly longer pendency times, with lower hazard rates caused by the higher number of amendments, claims, share of X references and other factors. We discuss general implications for the functioning of the patent system and address the detrimental effects caused by the high degree of uncertainty generated by these filings strategies. Possible solutions such as better coordination efforts are devised.

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1 Introduction

Strategic patenting has received a fair amount of attention among researchers in the field of strategic and intellectual property management, and industrial economics (e.g. Hall and Ziedonis 2001, Blind et al. 2006, Cohen et al. 2002). Previous studies on this topic discussed several forms of strategic patenting such as (offensive or defensive) blocking of competitors, patenting exchange and cross-licensing, and reputation or signaling motives. Common to all of these motives is a missing link of the decision to patent with the original protection purpose of the patent system (Blind et al. 2006).

This paper addresses the application process within strategic patenting induced by presence of technology standards. We discuss the incentives of patent applicants to deliberately shape this process and examine the characteristics of the outcome (i.e. the granted patents) in the standardization context with respect to two dimensions: the "patent scope" and "time to grant" of the application. Both dimensions are important elements of market power for patent applicants. The patent scope has frequently been analyzed in the literature (e.g. Hall et al. 2005, Lanjouw and Schankerman 2004, Lerner 1994). It refers to the number or variety specific aspects in technological field which are protected by an individual patent and can be measured in various ways (e.g., by the number of classes in the International Patent Classification scheme that the patent is assigned to by the patent examiner (Lerner 1994).) Far less attention has been paid to the importance of time in the process of patenting and its competitive elements. Time is a major factor when the objective of a patent application is to create uncertainty among other market participants about the real scope of protection and about the value of the technology in the application. In times of increasing backlogs at patent offices with a world-wide stock of pending applications far over two million, the strategic value of pending rights can be enormous.

Concerning patent scope, it is of genuine interest to patent applicants to have a granted patent with claims covering the maximum scope of protection and thus being of maximum value. A broad scope guarantees a high freedom to operate and makes it more difficult for competitors to work around the invention. In many cases, the patent examiner will cut back the initially listed claims, because the scope of protection violates the "unity of invention". Thus applicants (or their legal representatives) will design and amend the claims carefully to ensure protection of the most relevant components. This paper analyses one of the aspects which applicants take into account when filing or subsequently amending their claims: industry standards. Among them, the most important case can be seen in compatibility standards in telecommunication. Firms participating in standard-setting organizations (SSOs) aim to have their own patents included in the list of a standard's essential patents.[1] If this goal is met, the IPR holder can expect a substantial leverage of the patent's value, either in the form of an increased market and bargaining power in negotiations with competitors or in the form of royalty payments since firms willing or having to implement the standard could be forced to license the relevant IP.

The goal of applicants is thus not necessarily to obtain the broadest protection possible but to achieve a fit with the expected standard. How can applicants achieve this conformity? As pendency times are getting longer in patent offices around the world (WIPO 2009) and as the development of standards can be a matter of years, companies make use of the possibility to change their initially filed claims. This is perfectly legitimate if the examiner opposes certain claims or requires the applicant to adapt the application to make it patentable. On the other hand - and this could be the case with patents relevant for standards - applicants can also try to strategically shift the exact protection of the patent if they become aware of decisions in the standards committee leading to certain technological specifications. In a worst case scenario, the hold-up problem, which standardization can help to alleviate (Shapiro 2001), can be even more problematic. This would be the case if patent holders deliberately withhold patents needed for standardization ("patent ambush"). How often these problems occur in practice is hard to tell. Stakeholders in standardization report that in the vast majority of cases, there are no substantial problems with IPR in standards. However, there are several important lawsuits and regulating authorities' investigations on aspects such as "patent ambushing", but also the alleged deceptive behavior where participants at SSOs "gained information about the pending standard, and then amended its patent applications to ensure that subsequently-issued patents would cover the ultimate standard."[2]

Furthermore - and this leads to the time dimension of this analysis which has so far received sparse attention in the literature[3] - applicants have an incentive to keep the application pending in order to adapt the claims. In the context of standards, this incentive,

[1]According to the directives the European Telecommunication Standards Institute (ETSI), "essential" as applied to IPR means that it is not possible on technical (but not commercial) grounds, taking into account normal technical practice and the state of the art generally available at the time of standardization, to make, sell, lease, otherwise dispose of, repair, use or operate equipment or methods which comply with a standard without infringing that IPR. (Annex 6 of the ETSI Rules of Procedure, Article 15.6)

[2]Rambus Inc., FTC Docket No. 9302, Opinion of the Commission 3 (Aug. 2, 2006), page 4, available at http://www.ftc.gov/os/adjpro/d9302/060802commissionopinion.pdf

[3]Exceptions are Harhoff and Wagner (2009) and Regibeau and Rockett (2010).

however, might change depending on the progression of the standards development. At the beginning of the process, with high uncertainty about the future standard specifications, it is crucial to keep the application pending to preserve room for maneuver. On the other hand, once a standard has been defined, it is of utmost importance to have an essential patent fixed so that a share of the standard's licensing fees can be claimed.

We test empirically whether essentials patents are adapted more frequently and are pending longer. For this purpose, we compare a number of patents disclosed as essential for standards developed at European Telecommunications Standards Institute (ETSI), a major SSO responsible for widely used standards such as GSM or UMTS. In a first step, we match the information on "essentiality" to a new database of patent applications containing information on procedural EPO data, especially on the number of amendments and relevant dates such as application and grant/refusal dates etc. We use two different control groups. One is constructed by a one-to-one matching approach with each match belonging to the same IPC subclass, the same filing month, and the same applicant. A wider control group includes only granted applications in the same IPC subclass and filing years of firms that do not hold essential patents.

Results strongly corroborate our hypotheses showing significantly higher outcomes in the "essential" patents group compared to the control groups for the number of claims, amendments and the extent to which divisional applications are used. Survival time analysis shows that these factors which are found to be prevalent among essential patents are responsible for longer pendency times. Furthermore, filings after the freezing date of the relevant standard show significantly lower number of amendments and shorter pendency times, reflecting a lower need to delay and amend the application once the information about the future standard is available.

Our results reveal a number of interesting aspects on peculiarities of essential patents. Although there are some limitations to our approach (e.g., we do not directly examine the content of the amendments to essential patents), our results reveal important interactions of standardization and patent applicant behavior and the patent system as a whole. These interactions should be taken seriously because the described behavior increases uncertainty in the patent system resulting in possible disincentives for own investment in research and development. Policy makers, IP offices, and standards organizations should therefore take these results into account.

2 Related Literature

As standardization is a relatively young field of research, we will briefly review some important and recent contributions and describe how our work is related to home. The theoretical literature on standards was pioneered by Farrell and Saloner (1988) who model the bargaining process within SSOs as a war of attrition between participants. They conclude that finding consensus in an SSO takes longer than a solution via the market mechanism (standards war). This finding plays a role in our analysis since a long standards development process will lead to more strategic patenting as a reaction to new developments during this time. Later important theoretical work on standards was done by Lerner and Tirole (2006) who concentrate on the SSO IPR policies and emphasize the possibility of IPR holders to choose an SSO most suitable to their interests. Empirical support for this model is shown in Chiao et al. (2007) where the connection between an SSO's orientation towards technology sponsors and their disclosure requirements is shown by analyzing a large number of SSOs. The organization of disclosure rules is also an important topic in order to prevent hold-up problems in an industry with many overlapping or complementary patents (Shapiro 2001). Standardization is a way to avoid hold-up problems, as it serves a coordination function. However, hold-up problems can be specifically severe in standardization , since a patent essential to a standard may mean market power ex post that was much weaker ex ante (Farrell et al. 2007). A further connected strand of literature is the work on strategic patenting and the motives to file patents (Blind et al. 2006, Hall and Ziedonis 2001). Blind et al. (2006) explicitly include "influence on standardization" as a particular motive to patent but found this to be of relatively low importance compared to both the traditional protection motives and other strategic motives. In a different paper, Blind and Thumm (2004) analyze the relationship between the rate of patenting and SSO membership and find support for their hypothesis that firms with a higher patent intensity are less likely to join standardization processes. Recent papers have turned to the level of the single patent in order to investigate peculiarities of essential patents. Rysman and Simcoe (2008) show that essential patents in four major SSOs are cited around twice as often as the control sample and that they receive citation over a longer period of time, with a strong increase after disclosure to the SSO. Bekkers and West (2009) analyze essentials in the development in GSM and UMTS and point out the high increase in the number of potentially essential patents. Furthermore, patents essential to the UMTS standard are held by a smaller proportion of companies than those essential to the GSM standard.[4]

3 Hypotheses

Participation in SSOs does not only induce incentives to over-patenting or opportunistic patenting, but also to shape the patenting process to the interest of the individual firm. Relevant parameters of applicants include the initial drafting of the patent application and especially the way patent claims are used.[5] The strategy connected with essential patents is most likely to initially focus on a broad scope that eventually covers the scope of the future standard. If necessary or required by the examiner, the claims can subsequently still be cut back to the ones that are eventually relevant. We argue that this strategy is especially important in the standard setting context, because the inclusion in the essential patents list leverages patent value and market power.

In addition, we argue that this attempt to create a broad scope by filing high numbers of claims will also be reflected in more X or Y documents being detected by the search officer. X/Y documents are references added by the patent office during the patent search and indicate "particularly relevant documents when taken alone" (X document) or "when combined with one or more other documents of the same category" (Y document). If X or Y documents are found, "a claimed invention cannot be considered novel or cannot be considered to involve an inventive step" (EPO 2009).[6] If more claims are involved, it is more likely that at least one X or Y document is detected. Additionally, claims of essential patents might be framed broadly to cover a relevant standard. We argue that the detection of X or Y documents - as an effect of the higher number of claims and a broader scope - is more likely for essential patents than for the control group.

[4]Different work by Bekkers et al. (2002) also covers the ETSI essentials and shows that the dominance of firms in the telecommunication industry is strongly associated with the possession of essential IPRs.

[5]There is a significant increase in the number of claims in incoming applications at the EPO from around 12 in 1990 to more than 20 in 2004 (van Zeebroeck et al. 2009). Additionally, it seems to be a common strategy to file a high number of claims and let the examiner figure out the exact invention, thus shifting additional work to the search or examining division and at the same time generating uncertainty among competitors (see Guellec and van Pottelsberghe de la Potterie 2007, p. 165). Another purpose of filing large number of claims might also be to obtain a broader grant than justified.

[6]Strictly speaking, the breadth of the claims determines the likelihood of finding an X or Y document. In the literature the number of claims is often taken as a proxy for the breadth of a patent, because it raises the probability of an infringement and is connected with patent value. We follow this approach, but are well aware of the limitations of this proxy, interpreting the corresponding results with caution.

Hypothesis 1: Standards-relevant patents have more claims than patents than comparable patents not relevant for standards.

Hypothesis 2: The share of X or Y references is higher among standards-relevant patents than comparable patents not relevant for standards.

Amendments made to the initially filed claims are usually changes or restrictions induced by the substantive examiner indicating that the claims as they stand are not patentable. Rule 137 of the European Patent Convention sets out the legal basis for amendments: after receipt of the European search report, the applicant may, of his own volition, amend the description, claims and drawings. After receiving the first communication from the Examining Division, the applicant may, of his own volition, amend once, every further amendment needs the consent of the Examining Division.[7] However, it seems that patent attorneys often find ways to have the file amended more often, for example by deliberately keeping the set of claims deficient or amending a new set of claims introducing new subject matter, which is, in principle, ruled out by Article 123 EPC.[8] Nevertheless, applicants involved in standard setting have a strong incentive to change the wording of their application. They have better chances to get their patent included in the list of essential patents if the technical content of at least one of the patent claims and standard matches as much as possible. Every change in the standards document would thus make an additional amendment necessary. Consequently, the hypotheses to be tested in the empirical part are the following:

Hypothesis 3a: The number of amendments to the initially filed claims is higher for standards-relevant patents than for comparable patents not relevant for standards.

Hypothesis 3b: The share of multiple amended applications is higher among standards-relevant patents than among comparable patents not relevant for standards.

[7] In March 2009 the Administrative Council of the EPO issued new official terms for the Implementing Regulations to the European Patent Convention. As of April 1 2010 amendments can only be made after receipt of the search report, any amendments made to the description, claims and drawings must be identified and basis in the application as filed must be provided.

[8] We examine the indicator "multiple amended applications" as part of our analysis of the frequency of amendments. We define those as applications that were amended more than two times (see hypotheses below).

In order to be able to make amendments, an application has to be kept pending as long as possible; once the patent is granted, the scope (and the exact wording) of the application is fixed. There are numerous ways to prolong the pendency time of an application, even to a larger extent than caused by the backlog in patent offices worldwide. This includes choosing the filing route (e.g. Euro-direct versus Euro-PCT), which is a first potential strategy to gain time. After filing a patent application at a national patent office, applicants have 12 months to extend the application to any other patent office in the world. However, the Patent Cooperation Treaty (PCT) gives applicants the option to delay the international extension for 31 months. Thus, the filing route is a rather straightforward way to delay the patenting process and the additional time serves to prolong the period of time from the priority date to the final decision taken. More subtle ways include drafting practices and the way interactions with the patent office are handled. A common strategy to delay the procedure is to wait with certain actions (e.g. claims restrictions) until they can no longer be avoided or until the examiner summons to oral proceedings (Guellec and van Pottelsberghe de la Potterie 2007).[9]

Probably the most effective way to take advantage of an early priority date and to postpone the date of a final decision is the filing of divisional applications.[10] Two types of divisional applications can be distinguished: mandatory and voluntary divisionals. Divisionals can be demanded by the EPO because the original application does not meet the requirement of "unity of invention". As applicants in a standards-relevant industry might have an incentive to initially file large numbers of claims, the principle of unity of invention could be violated more frequently thus necessitating a split into two or more divisional applications.[11] In this case, a high incidence of divisionals would be an indicator of excessively broad parent applications.

However, applicants can also voluntarily split up applications into two or more divisionals.[12] The percentage of divisional filings and the degree to which these are voluntary differs considerably among technologies. Both numbers are among the highest in telecom-

[9]Guellec and van Pottelsberghe de la Potterie (2007) list more possible strategies under the heading "Slow track filing strategy" and "Deliberate abuse of the system".

[10]The EPO has experienced a sharp increase in divisional applications in recent years with an average rise of 12% per annum from 2002 to 2008. In 2008, the share of divisionals among all applications entering the European procedure was around 5% whereas from 1998 to 2001 it was around 2.7%.

[11]The validity of this argument again depends on whether the number of claims is accepted as an indicator of the breadth or scope of an application.

[12]In his decision in March 2009, the Administrative Council of the EPO imposed a time limit of 24 months after the Examining Division's first communication after which divisionals can no longer be filed. This applies to divisionals filed after April 1 2010.

munication. One possible reason for this is the importance of standard-setting in this industry. Applicants can increase the number of patents regarded as essential for a standard by filing divisional. This can improve their negotiating position on the standard's essential IP and their potential market power or licensing income increases. Additionally, creating uncertainty plays a role since potential licensees will be left with doubts about how much IP has to be licensed in order to being able to implement a standard. To sum up this last paragraph into testable hypotheses, we derive the two following hypotheses:

> *Hypothesis 4: The pendency time of standards-relevant patents is higher than among non-standards patents.*

> *Hypothesis 5: The share of divisionals among standards-related patents is higher than among non-standards patents.*

The timeline in Figure 1 illustrates the situation of concurrent patenting and standardization activities.[13] One can see how the ongoing standards development during time t=1 to t=6 creates the need to keep the application pending, since a grant in period t=5 would mean losing the possibility of adapting the application to the future standard. A subsequent attempt to amend the file and delay the intention to grant moves the point in time where the claims are fixed to after the freezing date of the standard.

4 Empirical Part

4.1 Description of Data and Matching Methodology

The following section describes the data used for the subsequent empirical analysis. The data contains patent process data, namely the information on how often a single patent application was amended before a decision about grant or refusal was made.

Our unit of observation is the individual patent application in IPC G and H active at the European Patent Office from 1998 to 2001. We have information on the application

[13]The figure shows only one possible situation of the chronological overlap between patenting and standardization. It goes without saying that other temporal situations (indicated with dashed brackets) are possible.

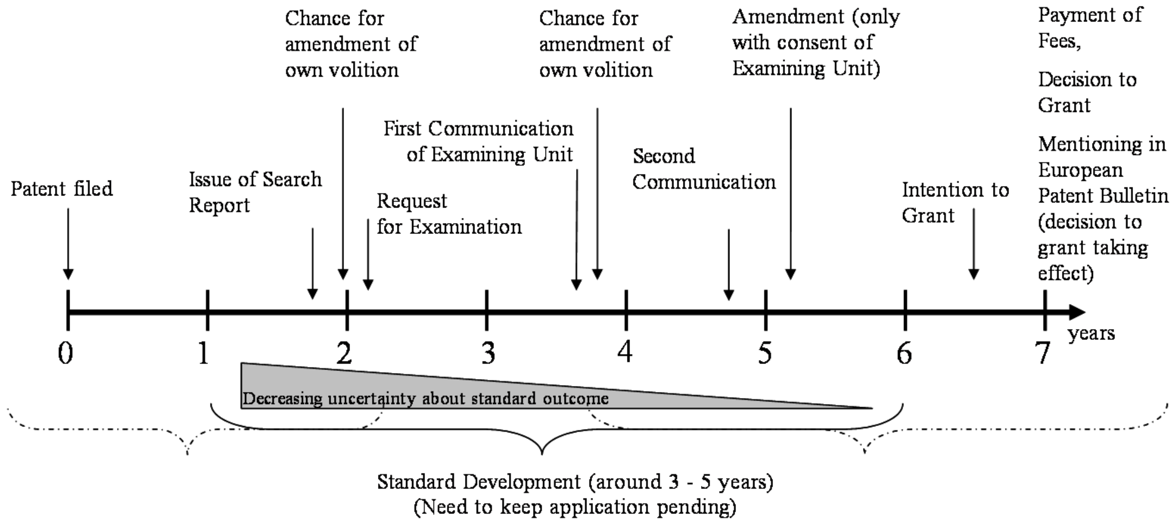

Figure 1: Example of timeline with overlapping examination and standardization periods

procedure for every application including the filing date, the filing route, the number of claims, the number of amendments made to the application and the pendency time (calculated as the filing date until the date of intention to grant or refuse the patent or the date at which the application is deemed withdrawn). This gives us a rich source of data on the life cycle of every single application. We match the OECD citations database to this dataset to obtain information on the different types of backwards (patent literature, non-patent literature) and forward citations. Next we obtained the information on a patent's potential relevance to a standard application by analyzing the ETSI's database of essential patents. Not all declarations to the SSO can be used because our dataset on procedural data contains EP filings only.[14] Furthermore, constraints on the information on amendments and other reasons forced us to only consider filings from 1998 to 2001. The total number of identified granted essential patents used is 305.[15]

We identified the statistical "twin" for each essential application based on three criteria employing a three-step matching procedure. First, we identified all non-essentials in the 4-digit IPC subclass level, filed in the same month by the same applicant. Secondly, we randomly selected one of these as control patent. This procedure yielded 227 matches.

[14]At the date of retrieval (February 2009), there were around 1500 declarations related to EP patents. However, the data quality of a large number of these declarations is not sufficient, because there was no reference to a specific (EP) patent or there were duplicate entries with a single patent being declared essential several times.

[15]About half of the essentials are connected to the UMTS project, followed by declarations concerning the GSM project accounting for 30% of the essential declarations.

If we were not able to identify a suitable match, the time criterion was broadened to the same application year, yielding 54 "statistical twins". In the third step, ten essentials were matched to a control patent with same IPC subclass, same filing year, but different applicant.[16] No suitable match could be identified for the rest of the essential patents (14 patents) and they were thus dropped from the analysis.[17] The final number for our analysis is 291 essential patents. The aim of the matching procedure is to rule out a bias in the construction of the control sample and to control for differences between technology classes, timing issues and heterogeneity of applicant strategies.[18] We therefore compare only the matches using a paired (repeated measures) t-test.

The matching literature has identified a number of conditions necessary for an identification of causal effects in matching models. One of these conditions is the conditional independence assumption. This assumption implies that all covariates leading to a selection into the treatment have to be identified. In our case, this would mean that all characteristics have to be observed that lead to the "essentiality" of a patent. In our empirical setting, it is almost impossible to satisfy this condition. One reason for this is the "black box" of firms' negotiations in SSOs working groups or committees, which are not observable for us, but which crucially drive the decision about the inclusion of a patent into the standard. We think that we have captured the most important factors for the matching exercise by using applicants (only a small number of all companies in a sector has essential patents), timing variables (for different points in time the probability to be included in the standard is substantially different), and technology fields (in SDO we analyze here, ETSI, patents are very much focused on a few IPC classes). However, our matching approach might not be suitable to infer causal statements. Nevertheless, our observations can lend support for the notion that certain applicant behavior is associated with essential patents, which then leads to different outcomes as hypothesized in section 3

As described, our construction of the first control sample relies on a narrow matching

[16]We broadened the matching criteria in order to increase the sample size for the empirical analysis. We decided to maintain matching on the applicant in the second step, because we argue that it is more important to compare patents from the same applicant than comparing patents than were filed within the same month. Thus, we can control much better for company-specific characteristics. In robustness checks, we also limited ourselves to only those patents which were matched in the first step. We found that the broadening of the matching rules did not substantially influence the results.

[17]Since the number of patents which could not be matched is relatively small, we argue that a selection bias potentially introduced by dropping these 14 essential patents can be neglected.

[18]In the robustness checks we additionally match on the forward citations in order to rule out control for technological importance.

approach only comparing patents that have been filed by the same applicant. While this approach is appealing because it shows how filing behavior differs within companies, we additionally consider a wider control group consisting of 69,195 patents that do not belong to the companies which disclosed IP in the essential patents database.[19] This wider control group can reveal how the essentials differ compared to a wider average of applications in the relevant technology fields, which may also belong to applicants who were not successful in including their patents into the list of essential patents or those who did not intend to do so.

Finally, we justify why the essential patents database can be considered suitable for our purposes. It is indeed possible that not all patents declared as essential will ultimately be seen as essential by the SSO's working committee and will be included in the final specification of the standard. There is some evidence that a real essentiality might in fact not be given for a high number patents listed on an SSO's IP disclosure sheet.[20] For our purposes, however, it is irrelevant whether the patent is, in fact, technically needed for standard implementation. We merely exploit the declaration of potential essentiality and thus have an indicator of the motivation for the observed behavior in the application process.[21]

4.2 Descriptive Analysis: Claims, X/Y Documents, Amendments and Divisionals

First, we will analyze how the number of claims in an application differs between the groups by analyzing this parameter in essential patent applications and in the control groups. Our comparison shows that there is a pronounced difference: while patents in the treatment group (i.e. the essential patents group) have on average more than 20

[19] The criteria filing year and IPC subclass are maintained.

[20] Goodman and Myers (2005) claim that only 21% of declared patents in 3GPP and 3GPP2 are actually essential.

[21] On the other hand, it is often the case that patents that are in fact essential are not submitted to the SSOs or are only submitted in late stages of the standards development process (patent ambushing).This would mean that our control group would potentially also contain essential patents thus biasing the comparison. However, since we only focus on patents filed from 1998 to 2001 for a standard that was developed at that time, we think that if a firm indeed held an essential patent, it would most likely have declared it to the SSO by the time of data collection for this study in early 2009. Failing to submit relevant IP seems unlikely since the firm would lose its strategic advantages. Thus, the number of standards-relevant patents in the control group not declared as essential patents should at worst be very small and therefore does not challenge the measurement approach of our empirical analyses.

claims, the mean in the matched control group amounts to only 17 to 18 claims (table 1) and to 16 in the wider control group. The difference between treatment and control groups is statistically significant at the 1% level. This could be an indication that applicants of standard-relevant patents draft broader applications covering a wide range of potential outcomes of the standard being developed. If this is true, applicants possibly also run a larger risk of claiming non-novel applications which would be identified by a higher share of applications with X or Y documents being added by the search officer. The share of applications that do not meet the requirement of novelty or inventive step seems indeed to be different in the two groups. The percentage is 0.56 for the control group and 0.67 for the treatment group. A two-sample test of proportions reports a significant difference at the five percent level.[22] Combining the two observations of systematically higher numbers of claims in the essential patents group with higher rates of X and Y documents found by the examiner could lead to the assumption that applicants draft the "essential" applications relatively broad in order to cover certain standard-relevant subject matter.[23]

After having analyzed the static view of claims and X and Y references, in a next step we turn to the dynamics of the claims and analyze how often applicants change their set of claims. As table 1 clearly shows, the average number of amendments is higher in the treatment group (on average 1.5 amendments compared to 1.2). Similarly the share of applications which are amended more than two times almost doubles in the group of essential patents. This supports our view that (multiple) amendments can be seen a strategic tool which is important for adapting the own patent application to an evolving standard.

A further strategic instrument to keep the examination process of patentable subject-matter pending and at the same time increase the mere number of patents which could be relevant to a standard is the filing of divisional applications. Comparing the share of divisional applications of essential patents with the patents of patent holders not holding

[22]For the comparison with the wider control group no significant difference can be observed.

[23]Another theoretical argument on citations measures can be assessed in this context: potentially essential patents are highly embedded in the standard-setting process and could be expected to make more references to technical documents outside the patent literature. These can be measured by the share of non-patent references in the search report. There is, however, no significant difference to be detected in overall non-patent literature references or in references to non-patent literature that are considered as an X document. The most likely explanation is that the integration in scientific work outside the patent literature is technology-specific (and high in ICT compared with other IPC classes) and not explicitly related to standardization. We thus do not detect differences between our treatment and control group.

	Group	Obs	Mean	Std. Err.	
Average number of claims	Matched Patents	291	17.82	0.6338	
	Essential Patents	291	20.37	0.8261	
	Difference		2.55	0.9261	$Pr(\|T\| > \|t\|) = 0.0063$
	Non-Essential Holder	69195	15.73	0.0479	
	Essential Patents	291	20.37	0.8261	
	Difference		-4.63	0.7414	$Pr(\|T\| > \|t\|) = 0.0000$
Share of patents with at least on X/Y document	Matched Patents	203	0.56	0.0348	
	Essential Patents	180	0.67	0.0351	
	Difference		-0.11	0.0495	$Pr(\|Z\| < \|z\|) = 0.0277$
	Non-Essential Holder	59982	0.63	0.0019	
	Essential Patents	180	0.67	0.0351	
	Difference		-0.03	0.0351	$Pr(\|Z\| < \|z\|) = 0.3895$
Average number of amendments	Matched Patents	291	1.15	0.0605	
	Essential Patents	291	1.51	0.0702	
	Difference		0.37	.0916	$Pr(\|T\| > \|t\|)= 0.0001$
	Non-Essential Holder	69195	1.21	0.0041	
	Essential Patents	291	1.59	0.0703	
	Difference		-0.31	0.06273	$Pr(\|T\| > \|t\|) = 0.0000$
Share of grants with three or more amendments	Matched Patents	291	0.09	0.0173	
	Essential Patents	291	0.18	0.0226	
	Difference		0.09	0.02856	$(\|T\| > \|t\|) = 0.0029$
	Non-Essential Holder	69195	0.11	0.0012	
	Essential Patents	291	0.18	0.0226	
	Difference		-0.069	.0186	$(\|T\| > \|t\|) = 0.0002$

Table 1: Comparison of treatment groups and control groups: claims, X/Y documents and amendments

	Group	Obs	Mean	Std. Err.	
Share of divisionals	Matched Patents	291	0.068	0.0148	
	Essential Patents	291	0.048	0.0125	
	Difference		0.020	0.0194	$Pr(\|Z\| < \|z\|) = 0.2889$
	Non-Essential Holder	69195	0.028	0.0006	
	Essential Patents	291	0.048	0.0125	
	Difference		-0.020	0.0125	$Pr(\|Z\| < \|z\|) = 0.0422$
Pendency time	Matched Patents⋆	259	68.44	1.4598	
	Essential Patents⋆	259	65.30	1.3704	
	Difference		-3.14	1.7128	$Pr(\|T\| > \|t\|) = 0.0681$
	Non-Essential Holder⋆	67222	60.79	0.0879	
	Essential Patents⋆	277	65.79	1.3477	
	Difference		-5.00	1.3726	$Pr(\|T\| > \|t\|) = 0.0003$

⋆ divisional applications excluded

Table 2: Comparison of treatment groups and control groups: divisionals and pendency time

essentials in the same IPC subclass, we see a share of divisionals which is around 1.7 times larger. Using our matched sample approach, the difference becomes insignificant (figure 2). Therefore there is somewhat ambiguous evidence on the relationship of the rate of divisionals with the relevance to standard setting. Conversations with patent professionals, however, suggest that the filing of divisionals is more likely to be the outcome of strategic patenting behavior.[24] As the relation to a standard makes an articulate patent strategy more important, it is reasonable to assume that our results reflect an intentional strategy, causing detrimental effects such as an increased workload for the patent offices and legal uncertainty among competitors and potential users of the future standard.[25]

4.3 Multivariate Regression Results: Pendency Time

So far our hypotheses related to the number of claims, amendments, and divisionals been confirmed by the univariate statistics presented above. Next, we will turn to the effects of our observations for the parameters discussed. Since each amendment leads to additional work for the examining unit and each divisional application prolongs the

[24]We conducted a number of personal interviews with patent attorneys and examiners on this issue.

[25]Unfortunately we cannot distinguish between mandatory and voluntary divisionals. Thus it is also possible that the high number of claims shown above translates into a higher probability of “non-unity” under Art 82 EPC and thus into a higher share of mandatory divisionals.

decision from the (legal) filing date to the final decision, this is very likely to affect the pendency time of patents. This section examines the differences in pendency time among essential patents and the control group and determines the influencing factors by using multivariate methods.

We start with a nonparametric survival analysis and estimate the Kaplan-Meier survival function.[26] Figure 2 shows the survival functions for essential and non-essential patents. Results do not clearly reveal differences in pendency times as the survival curves are located close to each other. Additionally, a Wilcoxon (Breslow) test for equality of survivor functions suggests that there is no significant difference. This similarity in the pendency time between the treatment group and the matched control group has already been evident in a simple comparison of the pendency times in table 2. However, the comparison with the broad control group showed significant differences. A closer look at sample subsets reveals further interesting results. Within the group of files that are granted relatively fast (within 5 years), the pendency times for the essentials are longer (significant at the5% level). However, among the files with longer pendency times, the essentials are on average finalized earlier than the control group (χ^2 value = 2.29). We interpret this finding as a sign that there is a substantial benefit by delaying the patenting process only up to a certain point. It is rational for an applicant of standard-relevant patents to keep the application pending only in the early stages of a standard development. Once the standard gets closer to being finalized, it is important to have the patent granted in order to disclose the IP and to get it accepted as an essential patent so as to be able to claim licensing income based on implementation of the standard.

To further elaborate on the determining factors of pendency times, we estimate three different (semi-) parametric survival models to assess the influence of several factors that have been shown to be prevalent among the essential patents group: the number of amendments and claims as well as the share of divisionals while at the same time controlling for other factors that have been shown to influence the pendency time.[27]

The influential factors to be measured can be clustered into three groups: i) the strategic interaction with the EPO (number of amendments, filing of divisionals, using the PCT route instead of Euro-Direct applications, and filing high number of claims); ii) measures of technological complexity (number of references to patent literature as well as to non-patent literature and the share of X references); iii) value measures (the number of

[26]We exclude divisionals to rule out a bias in the calculated pendency times since the starting point for the pendency time of divisionals is the legal filing date of the parent application.

[27]See Harhoff and Wagner (2009).

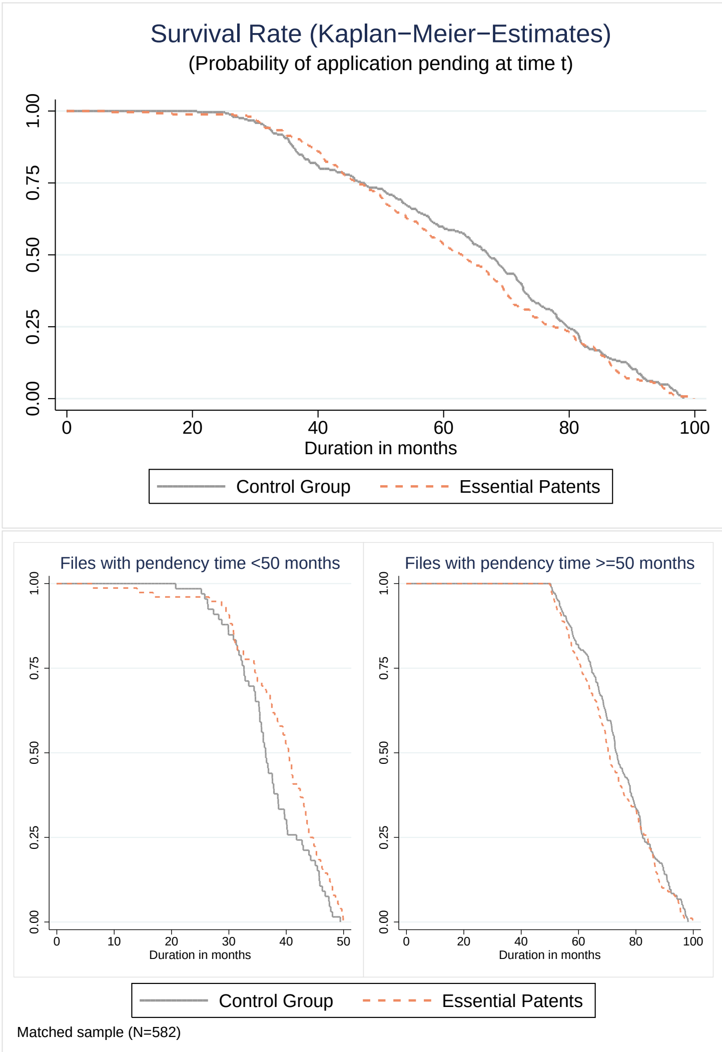

Figure 2: Kaplan-Meier Survival Functions of Essential Patents and Control Patents

citations received). In addition, time dummies for the filing year are included to control for the different levels of backlog at a given time.

We use three different survival models. A comparison between these models allows us to check the robustness of the results. First, we use a Cox Proportional Hazard (PH) Model, the reference model for multivariate survival models (Cox 1972). In this model, the hazard rate for a unit of observation (i.e., the instantaneous failure rate at any point in time, in our case the event of a patent being granted) is modeled as the product $\lambda(t,x) = \lambda_0(t)exp(x_1\beta_1 + ... + x_n\beta_n) = \lambda_0(t)exp(x'\beta)$. The baseline hazard $\lambda_0(t)$ function remains unspecified. The term $exp(x'\beta)$ scales the hazard rate up or down, depending on the covariates. It is common to interpret the estimated exponentiated coefficients (i.e., the hazard ratios). If the hazard ratio is smaller than one, we the baseline hazard rate decreases, which means that the estimated influence on the survival time is positive. In our case, this would mean that a factor prolongs the pendency time of a given patent. A further method for survival analysis are Accelerated Failure Time (AFT) Models. Here, the coefficients are assumed to directly influence (accelerate or decelerate) the survival time. IN AFT models, we have to make assumptions about the development of the hazard rate over time. We use two different parametrization. First, we assume a constant hazard rate. This is equal to an OLS regression with log(pendency time). Second, we use a log-logistic parametrization. This allows for a non-monotonic unimodal hazard over time. The actual shape parameter is estimated from the data. In AFT models, this distributional assumption has to be made. However, they have the advantage of allowing a direct interpretation of the exponentiated coefficients as changes of duration.

Table 3 lists the results of a Cox PH Model as well as an accelerated failure time model with log-logistic specification. All variables for which significant coefficients were obtained turn out to have a prolonging influence on pendency time. As both models yield consistent results, the following discussion will concentrate on the accelerated failure time model. Column (3) in Table 3 reports exponentiated coefficients which can be interpreted as the factor by which the pendency time is multiplied as a result of increasing the corresponding variable by one unit. When an application is a divisional (and thus enjoys the legal filing date of the parent application) and when the PCT route is chosen, the pendency time significantly increases by a factor of 1.39 and 1.06.[28]

Furthermore, every amendment increases the pendency time by about 8%. Considering

[28]The latter variable is not significant at the 10% level, just missing this threshold having a t-value of 1.60.

the difference in the 18% share of patents with at least 3 amendments in the essential patents group, this can be seen as a serious deferral factor. With regard to the citation measures, one can see that complexity measured by the number of references and especially the share of X references increases by 2.3% and 11.7% respectively. The patent value (measured as forward citations) does not have a significant coefficient. This contrasts the results of Harhoff and Wagner (2009) who find shorter pendency times for grants with higher value indicators. The reason for this difference is probably due to our focus on essential patents, which - as shown and argued above - differ considerably from the average grant in terms of both forward citations and in terms of the incentives to speed up or delay the grant process.

In summary, we find that a number of patent characteristics for which we found significant differences between essential patents and the control patents (the number of amendments, the share of divisionals, the share of X references) prolong the pendency time. Although a bivariate comparison of the pendency time between treatment group and matched patent group in table 2 yielded results would have led us to reject hypothesis 4, the combination of our various findings (the difference in pendency time between treatment group and the broader control group, the results on the differences in patent characteristics, and the multivariate models) lead us to a confirmation of hypothesis 4.

4.4 Robustness Checks

In the following section we present additional estimations in order to confirm the robustness of our estimations and to strengthen the link of the detected behavior with the participation in standardization:

First we investigate the possibility that amendments are more common among more valuable (measured as highly cited) patents and are therefore not necessarily connected to their standard essentiality. By matching on the forward citations we attempt to make the patents comparable in terms of “technological importance”. The matching procedure corresponds to the one described before, however, we now introduce a fourth matching variable and require the matched patents to have the same number or forward citations within the first three years of publication. Out of the 305 essential patents, we are able to find matches for 99 essential patents in the first step, 107 in the second step, and 67 in the third step. For 32 essential patents we were not able to identify matches.[29]

[29]We analyzed these patents to obtain insights why no match could be found. This is mainly due to

	(1) Cox-PH Model	(2) OLS	(3) AFT-Model
Number of Amendments	0.781***	1.091***	1.084***
	(0.0342)	(0.0147)	(0.0141)
Divisional Patent	0.386***	1.419***	1.387***
	(0.0777)	(0.0974)	(0.0909)
PCT Route	0.928	1.087**	1.063
	(0.101)	(0.0405)	(0.0407)
Number of Claims	0.999	1.000	1.001
	(0.00358)	(0.00122)	(0.00121)
Number of Patent Refs.	0.922***	1.021**	1.023***
	(0.0230)	(0.00846)	(0.00834)
Number of Non-Patent Refs.	0.957	0.999	0.997
	(0.0431)	(0.0152)	(0.0156)
Share of X Refs.	0.759*	1.114**	1.117**
	(0.110)	(0.0556)	(0.0545)
Number of Forward Citations	1.007	0.999	0.998
	(0.00775)	(0.00262)	(0.00245)
filed in 1999	1.633***	0.851***	0.854***
	(0.185)	(0.0320)	(0.0308)
filed in 2000	2.254***	0.753***	0.743***
	(0.296)	(0.0329)	(0.0323)
filed in 2001	2.898***	0.714***	0.736***
	(0.458)	(0.0369)	(0.0376)
Constant		56.20***	58.23***
		(3.149)	(3.201)
Observations	582	582	582
Exits	582		582
Log Likelihood	-3054.3	-204.9	-207.6
LR $\chi^2(11)$	147.1		136.0

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: unit of observation: individual granted patent; sample: essential patents as well as matched control patents

Table 3: Estimation Results from Cox Proportional Hazards Model, OLS on log(pendency time) and Accelerated Failure Time model (with log-logistic specification)

	Group	Obs	Mean	Std. Err.	
Average number of amendments	Matched Patents	273	1.17	0.0550	
	Essential Patents	273	1.46	0.0717	
	Difference		0.29	0.0894	$Pr(\|T\| > \|t\|) = 0.0012$
Share of grants with three or more amendments matched on forward citations	Matched Patents	273	0.08	.0165	
	Essential Patents	273	0.17	0.0229	
	Difference		0.09	0.0286	$Pr(\|T\| < \|t\|) = 0.0015$

Table 4: Comparison of the average number of amendments; control patents additionally matched on forward citations

The significant difference in amendments between the groups does not change: we obtain 1.46 amendments per application for the treatment group, only 1.17 amendments for the matched control group(see table 4). The difference between treatment and control groups is highly significant. We thus conclude that our observation is not an artifact caused by comparing more valuable patents with less valuable ones, but think that the difference in amendments is can be linked to the context of standardization processes.

Next we examine the notion that amendments are particularly important when there is high uncertainty about the standard to be developed and that this uncertainty declines substantially once the standard has been approved. The information on how to draft the patent document is better after this "freezing point" and therefore a lower number of amendments for later filings can be expected. Due to our data restrictions with respect to the number of amendments in this study, we only examine applications from 1998 to 2001. We use the UMTS standard as an example to investigate the development of amendments for filings early in this period with later ones. An important milestone for this standard was the "Release 99", defining the core of the UMTS standard at the end of 1999 (see for example Bekkers and West (2009)). We therefore compare the number of amendments made to patents declared essential filed in 1998 and 1999 with the ones filed once the specifications for "Release 99" were fixed.[30] We see that the share of patents amended at

an unusual citation rate of these patents (on average 6,6 citations within the first three years (median: 3).

[30]Please note that patents can be declared essential for the UMTS standard even though they are filed after the Release 99 freezing date. The reason for this that there are numerous follow-up version of the

		Group	Obs	Mean	Std. Err.	
Average number of amendments	only UMTS patents	Filing after f.d.	59	1.44	.1373	
		Filing before f.d.	97	1.69	.1297	
		Difference		-0.25	.1978	$Pr(T < t) = 0.1042$ †
Share of grants with three or more amendments		Filing after f.d.	59	0.10	.0393	
		Filing before f.d.	97	0.24	.0438	
		Difference		-0.14	.0588	$Pr(\|Z\| < \|z\|) = 0.0251$

† one-sided test ($H_a : diff < 0$), for two-sided test $Pr(|T| > |t|) = 0.2083$

Table 5: Comparison of the average number of amendments; UMTS patents only (filed pre/post Release 99 "freezing date"

least three times is more than 20% in the "pre-freezing point" filings, whereas it is only around 10% of UMTS patents filed in 2000 or 2001. The actual number of amendments amounts to 1.7 in filings in 1999 and 2000 and 1.4 in the later group.

Consistent with the argumentation that later patent applications do not have to be amended as much as earlier applications, we argue that the incentive to keep the application pending declines for later UMTS applications. Since all filings in our analysis have already been granted, we do not have to be concerned about right truncation and can start by comparing the mean pendency times between the early and late filings. As the backlog of applications at the European Patent Office has been growing during 1998 to 2001, one might expect that pendency times for later filings are longer. However, we see a pendency time of around 70 months for filings in 1998 and 1999 and only 57 months for filings in the following years. This is possibly because more deferral takes place when there is high uncertainty about the future standard compared to when the content of the standard is clear. The difference in the pendency times between earlier and later applications can also be seen by looking at the coefficients of the year variables in table 6. The reference year for the dummy variables is 1998. Looking at column (3), for example, we see that for applications with filing year 1999 the pendency time is smaller

UMTS standard, for which new technology was included. However, the Release 99 was such a crucial milestone in the standard development that the incentives to have proprietary technology included in this Release (and therefore also the incentives for amendments) were much higher than for the follow-up releases.

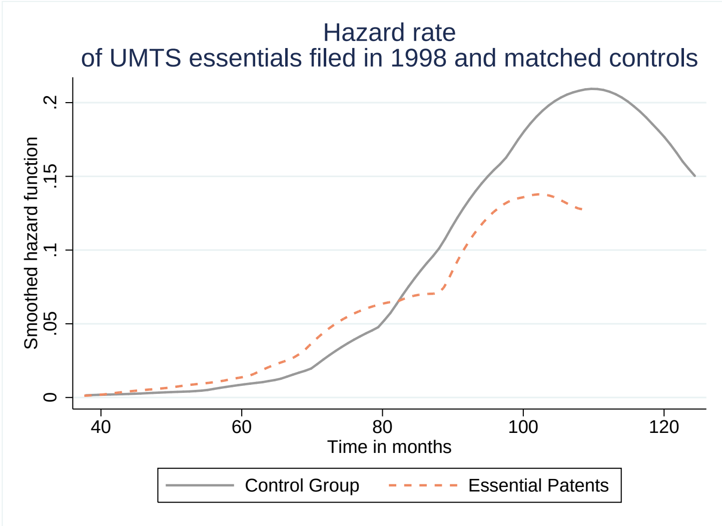

Figure 3: Hazard rate for UMTS essential patents filed in 1998 and their controls

than for the reference year. For applications after the "freezing date", the pendency time becomes even smaller, even though the general trend for the pendency time of all patent applications at the EPO was increasing for that time. These findings suggest that once the important milestone of the UMTS release 99 was established, the incentives for applicants to delay the patenting process decreased significantly.

The further explore this notion, figure 3 compares the hazard rates for essential patents filed in 1998 with the matched control patents. The hazard rates are derived from a Cox PH model based on this subgroup. Here we want to explore differences between the hazard rates for the essential patents before and after the freezing date. However, since the time period between filing in 1998 and the freezing date in 1999 is not sufficiently long. During this time, the applications were simply awaiting the first office action at the EPO. However, we see that the hazard rates for the essential patents is higher than the ones for the control groups up to a certain point. A reason for this observation could be that applicants have particularly strong incentives to bring the patenting procedure to an end as soon as possible. They have managed that their technology was included in the UMTS standard and now need to have a granted patent in order to legally secure this technology. This finding complements the interpretation of the survival curves in figure 2 and provides additional evidence about differences in the patenting process of essential patents and the control group.

	(1) Cox-PH Model	(2) OLS	(3) AFT-Model
Number of Amendments	0.729***	1.127***	1.118***
	(0.0591)	(0.0300)	(0.0280)
Divisional Patent	0.607	1.455***	1.383**
	(0.247)	(0.206)	(0.180)
PCT Route	0.753	1.276***	1.186**
	(0.182)	(0.101)	(0.0935)
Number of Claims	1.004	1.001	1.001
	(0.00627)	(0.00227)	(0.00208)
Number of Patent Refs.	0.934	1.005	1.010
	(0.0483)	(0.0162)	(0.0155)
Number of Non-Patent Refs.	1.049	0.963	0.956
	(0.108)	(0.0334)	(0.0319)
Share of X Refs.	0.581*	1.218*	1.177*
	(0.175)	(0.123)	(0.113)
Number of Forward Citations	1.032	0.994	0.994
	(0.0220)	(0.00709)	(0.00616)
filed in 1999	1.261	0.876	0.876*
	(0.309)	(0.0747)	(0.0662)
filed in 2000	2.250***	0.724***	0.702***
	(0.640)	(0.0701)	(0.0616)
filed in 2001	2.498**	0.608***	0.671***
	(0.934)	(0.0721)	(0.0776)
Constant		47.24***	50.16***
		(5.944)	(6.032)
Observations	156	156	156
Exits	156		156
Log Likelihood	-613.5	-54.47	-51.79
LR $\chi^2(9)$	43.69		56.95
adjusted R^2		0.2867	

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Estimation Results for survival analysis of UMTS relevant applications (reference for year dummies: 1998: year dummy for 1999 indicates filing before Release 99 "freezing date", dummies for 2000 and 2001 filing after "freezing date")

5 Conclusion

In this paper we have empirically analyzed the incentive effects for patent applicants participating in standard setting organizations to strategically shape the application process of potentially "essential patents" to their interest. While patent applicants will naturally try to achieve the broadest claims and the strongest protection for themselves, this motivation is highly magnified in the standard setting context. All parameters which allow the applicant to influence and delay the application process seem to be used to a much higher extent for essential patents. As a consequence we find a number of interesting facts. First, essential patents contain significantly more claims, potentially in an attempt to cover subject matter under standardisation. Secondly, we showed that essentials are amended around 25% more often than patents not relevant for the standardisation context. Thirdly, the time until a final decision about the application is reached is significantly longer for essentials. A reason could be the need for applicants to keep the filings open until there is a higher certainty about the outcome of the standardization process. Furthermore, we have shown that the chronological concurrence between the development of the standard and the patenting process is not coincidental: if an application is filed in the early stages of the standardization process, the incentives to retard the grant are high since there is a high degree of uncertainty about the specifications of the future standard. These incentives change after the standard specifications are frozen and the willingness to close the application process is now given to a larger extent.

There are some limitations of this research that should be noted. We have relatively rich information on the patenting process thanks to the procedural data from the EPO. However, as we could not analyze the actual content of the amendments and the corresponding standards document, we should be cautious in interpreting our results. The same reservations apply to the well-know shortcomings of indicators such as patent citations. The most important black box, however, seems to be standardisation process itself and the company behavior within working committees responsible for drafting standard documents. This insider information is almost impossible to observe and is therefore highly problematic from the empirical researcher's point of view.

Nevertheless, we can point out some implications of our results. It is important to bear in mind that this analysis is not about patents or standards themselves and is not an end in itself. It is ultimately about potential negative welfare effects related to essential patents. This includes potential impacts on the level of research and development conducted in an economy. The fact that a firm faces a competitors' patent application which is pending artificially long can result in underinvestment in R&D spending since the risk of being eventually confronted with a valid blocking patent has to be taken into account. This essentially an effect of the hold-up problem (Farrell et al. 2007). If an SSO is locked into a specific technology, it can be difficult to establish technological alternatives. Thus, the technological development can be retarded until the hold-up problem is resolved. This is also a public policy problem, because downstream consumers are harmed when excessive royalties are passed on to them or when innovation is retarded by patent hold-up.

Another issue are competition effects: If applicants manage to include (too) many patents in the essential patents lists merely by strategic behavior, they obtain a disproportionate degree of market power. Barriers to entry are created and collusion through horizontal cooperation between big industry players is a danger. We mention some aspects for improvement to potentially mitigate this problem. These aspects are certainly no panaceas, but could be useful to consider in more detail in future research.

The first is related to the interdependence of patenting and standardization. There is clearly a need for closer cooperation between patent offices and standard setting organizations. Art. 115 of the European Patent Convention allows third parties to communicate documents relevant to the examination of a pending application. This rule could be exploited to improve information sharing between SSO's and patent offices. If examiners had better access to documents discussed in SSO's working committees, it would be potentially easier to detect mere "claims shifting" to make it fit to a standard as the reason for an amendment. This could deliver good arguments to the examiner to refuse questionable requests for amendments. The same goal can be reached by "early warning systems" for suspicious cases or by special training sessions for examiners.

Both patent offices and standardization organizations could benefit from such coordination. One of SSO's main concerns is patent ambushing, i.e. companies not disclosing relevant patents until very late in the standardization process. If there was a way for patent offices to identify standards-relevant applications and if they indicated these applications to SSO's, this threat would be moderated substantially. A practical step would be a better integration of patent offices' and SSO's databases (e.g. an automatic updating of SSO databases with information from patent offices).[31] Another potential solution could be the communication of "track changes" in the examination process by the patent offices to SSO's or other relevant authorities. Coordination efforts would also improve the

[31]EPO efforts to "shine a light" on the patenting process in order to reduce uncertainty for applicants are based on the same idea.

situation of “weak” pending patents, i.e. applications declared essential, but - due to the claimed subject matter - with rather low chances of being granted. Again, if questionable applications could be indicated to the SSO’s the information asymmetry between IP holders and SSO could be more leveled out.

With respect to the functioning of the patent system itself, an adaptation of patenting rules should be considered in order to limit the extent of this abuse of the patent system. A first step has been taken by the European Patent Office by limiting the possibilities to file divisional applications which largely contribute to longer pendency times and to uncertainty in the system. A restriction to the use of amendments seems to be adequate (at least in some cases) to reduce the room to maneuver within application process and to reduce overly long times pendency times. The final objective should be an acceleration of the patenting process by preventing problematic applicant behavior and by improving the performance and efficiency of patent offices. This could reduce the uncertainty in the patent system to a minimum and promote the innovation enhancing features of the system and at the same time reduce harmful features.

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