Mapping Standards to Patents using Databases of Declared Standard-Essential Patents and Systems of Technological Classification

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Abstract

This paper describes a new database of declared Standard-Essential Patents (SEPs), discusses methods for matching declared SEPs with technology standards, and presents empirical evidence on technology standards subject to declared SEPs. While there is a growing body of empirical research using data on declared SEPs, this research has so far focused on the declared patents, and neglected the implications of SEP declarations for specific standards. Furthermore, we present a new methodology for matching standards with technology classes, using the classification of declared SEPs. This method allows identifying standard-related patents that have not been declared as essential, and provides a measure of standard-related patenting that is not affected by strategic incentives to declare a patent. The paper discusses opportunities for new empirical research using databases of declared SEPs and data on patenting in standard-related technology classes.

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1. Introduction

Patent statistics are an important window into technological innovation. Economists use widely available databases with bibliographic characteristics of patents, and in particular patent citations, to study e.g. inventive activities, technology transfer and productivity growth. Standard statistics are not yet as widely used in economic research, but bibliographical information on technology standards may provide complementary information on processes of technological progress and change (Baron and Schmidt, 2014; Baron and Spulber, 2015). In particular, many instances of technological innovation can best be studied by combining patents and standards data. This paper discusses methods for mapping standards to technologically related patents in order to facilitate empirical research on technological innovation using data on both patents and standards.

Both patents and standards documents describe, define and codify technologies. The role and scope of patents and standard documents are however very different. Patents describe new inventions, and they constitute a temporary legal right to exclude others from using practices and products that are novel and original. Standards on the other hand define commonly accepted techniques. Standards reflect an agreement between different individuals, firms or other entities to use a particular method, which may be novel or not. Standards may also govern the access to technology, because Standard Setting Organizations (SSO) often require their members to license proprietary technology that is necessary for the implementation of a standard on specified terms.

In spite of being of a very different nature, patents and standards interact in several important ways. Most importantly, standards can prescribe methods which are protected by patents. If a standard cannot be implemented without infringing a patent, this patent is called a standard-essential patent (SEP). Patented methods may also be useful, but not essential, for implementing a standard. A patented method is called commercially essential for implementing a standard, if existing alternative methods are technologically inferior or not accessible on commercially viable terms. Many other patents protect inventions that implement a standard without being the only possible way to implement this particular standard. Furthermore, many patented inventions are made in the process of standard development (e.g. address a specific need or problem in a standardized technology), but not included in the standard. Indeed, many different firms make contributions to standards under development, and contributions are subject to vote by SSO members.

Standards and patents describe an interesting interaction in the development of new technologies. Firms, universities, public research institutes or other entities carry out research and development (R&D) and invent and patent a variety of new methods and products. The inventors of different technological methods along with the users of the technology and other stakeholders get together in standard setting organizations (SSO) to select particular methods for common use. The

standards developed in SSOs are an input for further inventive activity, resulting in the development of products and new technologies implementing the selected standard. Standardization and invention are in fact parallel processes: inventors respond to the needs and objectives defined by SSOs, and SSOs redefine standards based upon new technological developments.

Economists interested in technological innovation can learn a lot from analyzing patenting and standard development together as two different parts of the same process. The joint analysis of patents and standards is however not straightforward. Some patents can be related to specific standards, e.g. because they were declared by their owners to be standard-essential. Not all SEP declarations clearly reference a specific standard document. Other declarations reference standards, without specifying the standard version. Many declarations reference entire standardization projects (like LTE), consisting in hundreds or thousands of different standards. Furthermore, declared SEPs are not necessarily actually standard-essential, and not all actual SEPs are necessarily accurately declared. Finally, the population of patents directly related to a standardization project is much larger than the group of narrowly defined SEPs.

This paper describes several methods for mapping standard documents to technologically related patents in order to facilitate the joint empirical analysis of patenting and standardization. First, we describe the most comprehensive existing database of declared SEPs that currently exists. Second, we match declared SEPs to the Searle Center database of standard documents on the level of the standardization project, the standard and the standard version. This is the first database matching declared SEPs to specific standard documents. Third, we use information from the declared SEPs to map patents to standards using a detailed system of technological classification.

Examiners at patent offices classify patents into the fine-grained technology classes of the Cooperative Patent Classification (CPC) system. While the World Intellectual Property Organization (WIPO) has successfully created a technology concordance table between patent classes and industry sectors,[3] there is to date no system for relating CPC classes to standards or the International Classification of Standards (ICS). This study develops a systematic mapping of standards to patents based on the CPC classification.

The remainder of this article is organized as follows. Section 2 reviews the existing empirical literature on technology standards and patents, and discusses the data and methods that have been used in the past to study the interaction between standard development and patenting. Section 3 discusses the methodology of data collection and the construction of a database. Section 4 provides

[3] The WIPO concordance table and explanatory material can be consulted under the following link: http://www.wipo.int/ipstats/en/statistics/technology_concordance.html

descriptive statistics and statistical evidence derived from this new database. Section 5 discusses avenues for future research using this new database, and section 6 concludes.

2. Literature review

The interface between patents and technology standards has recently attracted wide academic interest and attention from policy makers. The current interest focuses on SEPs, i.e. patents that are necessarily infringed by any implementation of a standard. Some standards define complex technologies that are believed to include large numbers of inventions covered by such SEPs owned by many different firms. This situation has been referred to as "patent thicket" (Shapiro, 2001) and is often viewed as a reason for concern. Many authors raise the argument that "stacking" multiple complementary patents could lead to excessive levels of aggregate royalty rates (e.g. Lerner and Tirole, 2004; Llanes and Trento, 2012; Llanes and Poblete, 2014; Lerner and Tirole, 2015). Another perceived risk is the possibility of patent holdup, i.e. an opportunistic increase in royalty levels for a patent after an SSO makes irreversible choices in standardization, and after standard users incur sunk costs in implementing the standard (Lemley and Shapiro, 2006; Farrell et al., 2007) .

In the light of these potential problems, the attention has increasingly shifted to the rules of SSOs on disclosing and licensing SEPs. Many SSOs require their members to disclose patents that they believe to be potentially essential to a new standard under development, and to license their SEPs on fair, reasonable and non-discriminatory (FRAND) basis. One research focus consists in the attempt to formulate an economically grounded interpretation of such FRAND licensing commitments (Baumol and Swanson, 2005; Layne-Farrar et al., 2007; Sidak, 2013). Other researchers have empirically analyzed the differences in IPR disclosure and licensing rules both between SSOs and over time (Lemley, 2002; Chiao et al. 2007; Bekkers and Updegrove, 2012; Tsai and Wright, 2014; Baron and Spulber, 2015). Several papers investigate the economic effects of existing or suggested licensing rules (Ganglmair et al. 2012, Dewatripont and Legros, 2013; Layne-Farrar et al., 2014), or analyze the incentives and effects of patent disclosure in a dynamic standard adoption process (Layne-Farrar, 2011; Contreras, 2011; Ganglmair and Tarantino, 2012).

The SSO policies on the disclosure of potential SEPs are not only a subject of heated debate among economists. Declarations of SEPs also provide economists with data that can be used for quantitative research. Bekkers et al. (2012) compile data on SEP declarations from several SSOs, provide descriptive summary statistics and discuss methodological aspects of using SEP declarations data. They discuss time trends of SEP declarations at different SSOs, distinguish between different types of disclosure, and compare declared SEPs with control patents along several dimensions. While they standardize the names of the declaring patent holders and clean the patent numbers in order to

facilitate the match with existing patent databases (such as Patstat[4]), they do not standardize the information on which standard a patent declaration refers to, and do not match data on declared SEPs to databases of technology standards.

A growing empirical literature uses data on declared SEPs as a measure for patented technologies included in a standard. Bekkers et al. (2002) use data on SEP declarations for the GSM standard to describe the role of IPR in standardization. Rysman and Simcoe (2008) highlight an increase in the number of patent citations after a patent is declared essential, and interpret this finding as evidence that inclusion of a patent into a standard increases its value. Simcoe et al. (2009) analyze patent litigation involving declared SEPs. Layne-Farrar (2008) and Bekkers et al. (2011) analyze the factors determining that a patent is declared essential for a standard. Berger et al. (2012) document patent filing strategies for declared SEPs. Pohlmann et al. (2015) and Hussinger and Schwiebacher (2014) find that declared SEPs contribute more to firm profits or market value than comparable control patents. Bekkers and Kang (2013) and Kang and Motohashi (2015) match the name of the inventors listed on declared SEPs to the names of standardization meeting attendees and investigate the relationship between patenting and participation in standardization. All these contributions use the match between SEP declarations data and existing patent databases, e.g. to study how declared standard-essential patents compare to other patents. Baron et al. (2013) match declared SEPs to a sample of technology standards, and study how SEP declarations affect the further technological development of the standard.

Data on declared SEPs are however not a direct measure of patented technologies covered by a standard. The claim that a declared patent is essential to implement a standard is based only on the patent holder's own assessment and not evaluated by the SSOs. On the one hand, patent holders may have an incentive to over-declare patents as essential in order to increase their bargaining power in licensing negotiations, or because failing to declare a patent as essential may make it later-on more difficult to assert the patent against firms using the patented technology to implement the standard. On the other hand, patent holders have an incentive not to declare their patents as essential in order to avoid restrictive SSO rules on the licensing of SEPs. It is furthermore very difficult for a company representative to know all the patents of his employer that may potentially be essential for a standard under development, and to assess to what extent they would actually be essential for implementing a future standard. Finally, standards may also include patented technology owned by firms that did not participate in developing the standard. These firms often have no obligation to declare their patents.

[4] Patstat is a large database of bibliographical information on patents hosted by the European Patent Office (EPO) and the Organization for Economic Cooperation and Development (OECD).

Economists studying the interaction between patents and technology standards have therefore complemented the SEP declarations data with other sources of information. One approach is to use data on patents included in patent pools. Unlike SSOs, patent pools are required to evaluate the essentiality of patents included in a patent pool, and several patent pools publish detailed essentiality evaluation reports mapping specific patent claims to standard sections. These reports provide more reliable samples of presumed SEPs. Not all SEPs are however licensed out through patent pools, and the decision of a patent holder to join a patent pool depends upon the characteristics of the patents (Layne-Farrar and Lerner, 2011; Baron and Delcamp, 2015). Empirical data on patent pools (available on the Searle Center website)[5] is useful for empirical research on patent pools themselves (there is a large theoretical literature on patent pools with little empirical evidence),[6] but shed light only on a particular kind of patents in the larger population of SEPs.

The interaction between patents and standards is furthermore not limited to the sample of SEPs. A firm may have developed and patented a technology with the objective of including it in a standard, but the SSO decides not to select the proposed technology. Also, there frequently are multiple competing patented technologies that can be used for implementing a standard. Given the definition of essentiality, none of these patents is considered a SEP. SEPs are thus only the tip of the iceberg of patented technologies related to technology standards, and the declared SEPs or SEPs included in patent pools are only an approximate measure of the unobservable population of "real SEPs". A very different approach to study the interaction between patenting and standardization has been used by e.g. Gandal et al. (2004) and Blind and Thumm (2004). These authors use aggregate measures of patenting and standardization activities at the firm level. There seems to be a large gap between this very broad approach and the other approaches using narrowly defined samples of patents that are presumed to comply with the specific criteria of standard essentiality. Bridging this gap requires a mapping between standards and patents in order to identify the patents that are in the technological field of a standard (without being necessarily standard-essential or declared SEPs). Baron et al. (2014) and Baron and Pohlmann (2015) respectively use the technological classification of declared SEPs and patents included in patent pools to identify patents that are technologically similar to the presumed SEPs.

There are thus two important gaps in the currently available data used to study the interface between patents and standards. First, the existing literature almost exclusively compares declared SEPs to other patents and examines the strategies of filing, licensing or litigation SEPs. It thus does

[5] The data on patent pools includes longitudinal information on pool members and licensees. All data is accessible under the following link: http://www.law.northwestern.edu/research-faculty/searlecenter/innovationeconomics/data/technologystandards/

[6] E.g. Lerner and Tirole, 2004; Llanes and Trento, 2012; Llanes and Poblete, 2014

not compare standards subject to SEPs with other standards, and provides little information on the role of SEPs for standards. While the existing data provides evidence that declared SEPs are more valuable for their owners than other patents, there are many first-order questions on SEPs for which there is no available evidence. The policy debate regarding the IPR policies of SSOs should be informed by evidence on whether the inclusion of patented technologies increases the technological quality of the standard, incentivizes further investment in standard improvements, or affects the rate of standard implementation. In order to address these and other questions on the "standard side" of SEPs, we provide the first database matching SEPs with a comprehensive database of technology standard documents. The match between SEP declarations and standard documents is not straightforward, and we discuss in the following section the methodological challenges that need to be overcome.

Second, declared SEPs (and to a lesser extent patents included in patent pools) are currently the only measure that is used to identify patents related to a particular technology standard. Many patents that are related to technology standards are systematically not included in this data, either because the patent holder did not participate in developing the standard, because the patent describes a method that was not selected for the standard, or because there are alternative methods (including inferior methods) available for implementing the standard, in which case none of the methods is essential. Declared SEPs only provide a partial picture of the relationship between patenting and standardization strategies. Declared SEPs can however be useful to identify the technology classes that are related to a standard. We build upon the classification of declared SEPs to create a mapping of standards to patents, which can be used e.g. to study the effect of events in standardization on the incentives to patent, or how standardization strategies depend upon related patent portfolios.

3. Data and methodology

Declarations of Standard essential patents (SEP)

Many SSOs require the disclosure of SEPs. The disclosure is usually based on the good faith and personal knowledge of the company representative making the declaration, and SSOs do not carry out any verification of the claim that a patent is standard-essential. While we clean and standardize the information provided in the declaration statements, we make no attempt at verifying the accuracy of the essentiality declaration itself. By no means, individual SEP declarations can be understood as evidence of actual essentiality of the declared patents. Nevertheless, SEP declarations are typically the only comprehensive and systematic source of information available not only to the researcher, but also to economic agents interested in the standard. SEP declarations therefore

provide meaningful information that can be used in economic research. We therefore start with collecting information on declared SEPs, and discuss how we use these patents to identify the technology space in which standards are developed.

We retrieved lists of SEP declarations from the websites of the following major SSOs: ETSI, 3GPP[7], ISO, IEC, CEN, ITUT, ITUR, IEEE, IETF, OMA, ANSI, SMPTE, ATSC, OASIS, TIA, Broadband Forum, ATIS, The BluRay Disc Association and the DVD Forum. All of these SSOs require the public disclosure of SEPs, even though the specific aspects of the required disclosures may vary from one SSO to another depending on their IPR policy (see Baron and Spulber, 2015). These SSOs publish online databases of SEP declarations with information provided by the declaring firm, such as the date of declaration, the relevant standards and the patent number that are alleged to be standard essential. In some cases however, firms make so-called "blanket" declarations, whereby the patent holder only claims to own patents essential for a standard, without disclosing the patent number.

Retrieving information from SEP declarations can be challenging, because the original format of the SEP data is not harmonized. Company representatives typically hand in a SEP declaration form, which is in some cases handwritten. This handwritten page is sometimes published as a PDF scan or imported in the format of the SSO database. We made use of PDF parsers to automate the scraping process. In a second step, we created a harmonized structure summarizing the information in a single format. This is necessary because different SSOs provide different information on SEP declarations. We also create and assign harmonized company names.

Firms inform SSOs that they own SEPs for a particular standard in so-called disclosure letters (sometimes also called "Letters of Assurance", or LoA). We have retrieved information from 8,527 disclosure letters, and created the datafile **SCDB_Letter.dta**. We assign a unique id (*Letter_id*) to each disclosure letter. This id can be used to match the declaration information to the datafiles listing patents and standards. The file **SCDB_Letter.dta** also includes the name of the SSO to which the declaration was made, as well as the date of declaration, and the harmonized company name.[8]

We standardized the format of patent application and publication numbers listed in the disclosure letter. We then merged the cleaned patent numbers with Patstat to retrieve the patent family number (INPADOC ID). A patent family is defined as a group of patents with the same priority patent application, and includes e.g. equivalent patents filed in different countries. All patents of the

[7] Information on patents declared essential to 3GPP standards was accessed from the ETSI website. 3GPP is a consortium of seven SSOs including ETSI, and 3GPP standards are published by the seven organizational members as their own standards. In the following, all analyses presenting data on ETSI standards thus includes standards developed at 3GPP.

[8] SSO and company names can be matched to SSO and company IDs standardized across the Searle Center Database. Use **SCDB_SSO.dta** for SSO names and **SCDB_firm names.dta** for company names.

same patent family originate from the same invention. We therefore use the patent family number to remove duplicate declarations of the same patented invention.

We cross checked all patent numbers to ensure the data quality. SEP declaration registers may be subject to spelling mistakes. Furthermore, the automated retrieval of patent numbers from e.g. PDF files of scanned hand-written forms may induce errors. We therefore conduct quality checks by e.g. comparing if the first or current assignee of the patent matches the declaring company. In cases where the declaring company is not listed as any of the patent assignees, we manually checked the patent. In cases of doubt, we deleted patent observations that seemed not to be relevant for the standard in question.

The preceding analysis results in the datafile **SCDB_Decl_Patent.dta**. The file contains three variables, *Letter_id*, *patent_number*, and *INPADOC_id*. *patent_number* can be a patent publication or application number (depending on which number was declared). This file provides information on all patent numbers listed in each disclosure letter. In case of blanket declarations, the *Letter_id* is included, and *patent_number* and *INPADOC_ID* are blank. *SCDB_Decl_Patent.dta* contains 199,696 observations.

Next, we create the datafile **SCDB_Decl_Standard_des.dta**, which includes the standards or standard documents (*standard_designation*) referenced in each disclosure letter. We split lists of designated documents (e.g. separated by comma) into multiple entries of single standard designations. Otherwise, the spelling of standard designations is unchanged from the original disclosure letter. Declarations can be matched to specific standard documents using the harmonized *standarddoc_id* (see next section).

Table 1 lists the number of disclosure letters, declaring companies, declared patents and declared patent families by SSO. Most patents are declared at ETSI (European Telecommunications Standards Institute). ETSI has significantly contributed to the development of mobile telecommunication standards such as GSM. The numbers for ETSI also include data on patents declared essential for standards of the 3rd Generation Partnership Project (3GPP), a consortium of seven SSOs including ETSI, which has developed the UMTS and LTE standard families. ETSI acts as secretariat for 3GPP. At ITU-T, almost 2,000 SEPs were declared by 352 companies. At ISO, over 1,000 companies declare to own about 5,000 patents that are essential to standards, while at ETSI only 226 companies declare over 160,000 patents as standard essential. Differences among SSOs often relate to differences of the standardized technology. However, differences in the number of “blanket declarations” are often related to differences in the IP policy of an SSO. At ITU-T, IEEE and IETF the majority of declarations are blanket declarations.

sso	Letters	SEPs	SEP families	Blanket letter	Declaring companies
ANSI	442	276	236	249	128
ATIS	50	1	1	50	29
ATSC	11	134	24	0	9
Broadba Forum	32	23	19	21	20
CEN	14	18	16	4	12
DVD Forum	196	2,149	1,137	1	195
ETSI	1,453	105,185	19,794	0	161
IEC	409	101	92	353	169
IEEE	823	1,133	755	581	327
IETF	205	667	426	190	202
ISO	1,846	4,958	1,946	766	1,002
ITUR	138	334	249	79	71
ITUT	1,233	1,972	1,040	879	337
OASIS	68	48	40	53	44
OMA	109	524	346	74	48
SMPTE	21	210	65	0	21
TIA	214	26	25	208	63
The BluRay Disc Ass.	1,262	7,028	3,248	1	1,255
Sum	8,526	124,787	29,459	3,509	4,093
Total (no duplicates)	8,526	122,413	28,201	3,509	2,963

Table1 Declaration per standard setting organization

Matching SEP declarations to standard documents

The standard designations from the disclosure letter can reference a unique standard document (a specific version of a standard), a standard (without specifying the version), or entire standardization projects consisting in many different standards (such as LTE). Only very few declarations specify standard sections or chapters or other levels of disaggregation that are more precise than the standard document level. In order to match SEP declarations with the Searle Center Database of Technology Standards[9], we split standard designations into clean standard ids and version numbers.

[9] The Searle Center Database of Technology Standards (**SCDB_standard_documents.dta**) draws from multiple sources, including PERINORM, Document Center, IHS Standards Store, and the websites of multiple SSOs.

Declarations can be unambiguously matched to standard documents if they reference a standard number and a version number or date, or if they reference a standard number for which only a single version exists (some SSOs assign different document numbers to different versions of the same standard). Whenever we established a match on the document level, we assign the harmonized *standarddoc_id*. In many cases, declarations reference standard numbers without specifying the version number or date. We call this a match at the standard level, and define a standard as the group of all standard documents sharing a common version history (in most cases, these are different versions of the same standard[10]). All declarations that can be matched on the standard version level can also be matched on the standard level.

This information is provided in the datafile **SCDB_Decl_standarddoc.dta.** The file contains three string variables: *letter_id*, *standard_designation*, *standarddoc_id*. Each line indicates a match between a disclosure letter and a standard document id. The nature of the matching is indicated by four binary variables. The binary variable *unique* indicates whether the standard id or title in *standard_designation* uniquely identifies a single standard document. If not, there are at least two different documents with the same standard id (generally different versions of the same standard). *matchonv* indicates a match directly on the version level (the declaration specifies a standard version included in the database, e.g. by indicating a version number or standard publication year, or the Standard ID uniquely specifies a standard document). *matchons* indicates a match on the version level or on the standard level. This match includes matches on the version level, but also matches declarations that do not specify a version number or date to the version of the referenced standard that is in place at the time of declaration.[11] *matchonsinclfoll* indicates an inclusive match, including both preceding types of matches, as well as all standard documents following up in a version history to a version matched to a declaration.[12] This datafile can be used to identify all standard documents subject to a SEP declaration following a more or less restrictive definition.

Many declarations, especially at ETSI, don't reference specific standards, but broader standardization projects. We establish a match on the project level when a declaration explicitly references a standardization project, or when a declaration references a standard or standard version which can be assigned to one or multiple standardization projects. We use ETSI data to assign

[10] In some cases, standards are split up in different standards; or different standards are merged into a single standard. In these cases, different standard documents that coexist at the same time and describe different pieces of technology also share a common version history.

[11] It is possible that several of these matches are false positives, because the declaration is intended not for the current, but for a future version of the standard that is under preparation at the time of declaration.

[12] A researcher interested in the effect of SEPs on standards must make an assumption whether SEPs declared to a standard continue to be essential as the standard changes to a new version. Very often, this is likely to be the case. Using m*atchonsinclfoll* is based on this inclusive approach. A more conservative approach would use *matchonv* or *matchons*, resulting in fewer false positives and more false negatives (failures to match standard documents to declared SEPs that continue to apply).

ETSI and 3GPP standards to projects. We provide a table matching standard designations to projects: **SCDB_Decl_Project.dta**. Some declarations only designate the identity of the SSO, or a 3GPP release number (see Baron et al., 2015). We make no attempt to match these declarations to specific standards.

Table 2 shows the quality of the matching of declared SEPs with specific standard documents on different levels by SSOs. We count declarations as unique combinations of patents, standard designation, and declaration date.[13] Following this definition, the sample consists of 208,879 declarations. 182,739 declarations can be matched to specific standard documents included in the Searle Center database. In most of these cases (155,983 declarations), the standard name or number uniquely designates one standard document in the Searle Center database. 163,592 declarations can be unambiguously matched to standard documents, either because the standard name uniquely references a single document, or because the declaration references a specific version. Approximately 2,000 additional declarations can be matched to the version of the referenced standard that is active at the date of the declaration. 26,140 declarations could not be matched to specific standard documents, either because the declaration is too unspecific (many of these declarations, in particular at DVD and BluRay, reference only the SSO), erroneous, or because the referenced standard is not included in the Searle Center database. A large number of these declarations can however be matched to ETSI/3GPP projects.

SSO	Number of declarations	match	no match	unique	vlevel_ match	slevel_ match	slevelmatch_ inclfoll
ANSI	900	496	404	370	455	475	493
ATIS	50	0	50	0	0	0	0
ATSC	134	0	134	0	0	0	0
BluRay	7,054	0	7,054	0	0	0	0
Broadband Forum	53	0	53	0	0	0	0
CEN	35	35	0	13	24	33	35
DVD Forum	2,149	0	2,149	0	0	0	0
ETSI	180,115	165,659	14,456	140,346	147,844	149,223	160,464
IEC	946	883	63	337	352	541	770
IEEE	2,323	2,236	87	2,114	2,114	2,170	2,213
IETF	2,122	1,957	165	1,957	1,957	1,957	1,957
ISO	7,177	7,125	52	6,908	6,908	6,984	7,105
ITUR	468	452	16	411	411	421	449
ITUT	3,946	3,896	50	3,527	3,527	3,636	3,821
OASIS	128	0	128	0	0	0	0
OMA	836	0	836	0	0	0	0
SMPTE	210	0	210	0	0	0	0
TIA	233	0	233	0	0	0	0

[13] We also count a declaration as multiple declarations if a standard designation refers to multiple standard documents.

Sum	208,879	182,739	26,140	155,983	163,592	165,440	177,307

Table2 Declarations matched to standard documents in the Searle Center database

Mapping standards to CPC classes using declared SEPs

While declared SEPs are only a subset of the patents that are technologically relevant to standards, they can also be used to identify technological classes of patents that are technologically related to specific standard documents. Specifically, we use the technological classification of declared SEPs to assign standard-specific weights to CPC technology classes at the lowest level of disaggregation. There are more than 100,000 classes at this level of disaggregation, so that the CPC classification allows for a very precise mapping of standards to patent technology classes. Using Patstat, we can then count standard-related patent applications by standard and year and identify the most relevant patent holders in the field of the standard. We thus identify and count patents that are technologically very similar to the declared SEP for each specific standard.

We use our sample of SEP declarations, consisting in unique patent families being declared essential to specific standard documents, to standards or to standardization projects. We remove duplicate observations per patent family and standard, and identify for each patent family the CPC classification. Patents are assigned a primary CPC classification, as well as a number of extended CPC classifications. For each patent, we assign a weight of 0.5 to the primary CPC class, and distribute a weight of 0.5 over all CPC classifications, including the primary CPC class.[14] We create aggregate weights per standard and class by summing the weights per class over all patents declared standard-essential to a particular standard. The weights indicate how relevant a specific CPC class is to a specific standard.

The datafile **SCDB_standards CPC mapping.dta** provides the weights for almost 19,000 detailed CPC or IPC classes, mapped to 1,854 standard documents with harmonized document id and 78 broad standardization projects. The variable *tot_weight* indicates the weight of a specific class for a specific standard. The variable *tot_weight_standard* indicates the number of declared SEPs used to map this specific standard to CPC classes.[15] The variable *tot_weight_class* indicates the sum of weight contributions of this class to all standards in the sample. Classes with a high value of

[14] If a patent is classified into one primary CPC class and four extended the CPC classes, the primary CPC class thus receives a weight of 0.6, and each extended CPC class receives a weight of 0.1. The total weight for each declared SEP is 1.

[15] Researchers may decide to only use the mapping for standards for which tot_weight_standard exceeds a specified threshold. The higher this number, the larger the basis on which the mapping rests.

tot_weight_class are either very large classes (classes with many patent applications), or patents in these classes are more likely to be declared standard-essential.[16]

Using Patstat, we next create a count of all worldwide priority patent applications per year and per CPC classification at the most disaggregate level. We only use the primary classification for this count. For each standard and year, we multiply the class weights with the number of priority patent applications in this class, and sum this weighted count over all technology classes identified as related to the standard. This sum is a weighted aggregate count of all new patented inventions that are technologically related to specific standards.

This information is provided in the file **SCDB_firm_patenting.dta**. The variable *tot_patenting* measures the number of priority applications weighted by standard-relevance. We also provide a citation-weighted version of this measure, *tot_patenting_cw*. We count citations by patent family (different patent families citing any patent with this patent priority number). We account for truncation by discounting each patent by the average number of citations for a patent priority application from the same priority year.

4. Descriptive Statistics

4.1 Declared Standard Essential Patents

In this section, we describe our sample of declared SEPs. We provide time trends in the number of declared SEPs, and describe SEPs by ownership, technological field, and bibliographic characteristics. We retrieved additional patent bibliographic information from Patstat, including the legal status, number of citations, number of inventors, number of claims, family size, number of assignees and number of different IPC/CPC classifications.

In a first step, we made use of the different patent status codes in the INPADOC legal status field of each patent. Figure 1 shows the cumulative number of patents as to the date of publication. We differentiated between patents that expired, patents that lapsed (failure to pay the maintenance fees) and patents that are still active. Remarkably, most of the patents declared as standard essential are still active and only a share of about 10% expired and a share about 8% lapsed until the year 2014. Especially the low percentage of lapsed patents hints to high perceived value of SEP, since maintaining a patent involves substantial expenditures in maintenance fees.

[16] Researchers may decide to discount tot_weight by tot_weight_class. Classes with a high value of tot_weight_class are "generic" classes and less useful to discriminate between the technological fields of different standards.

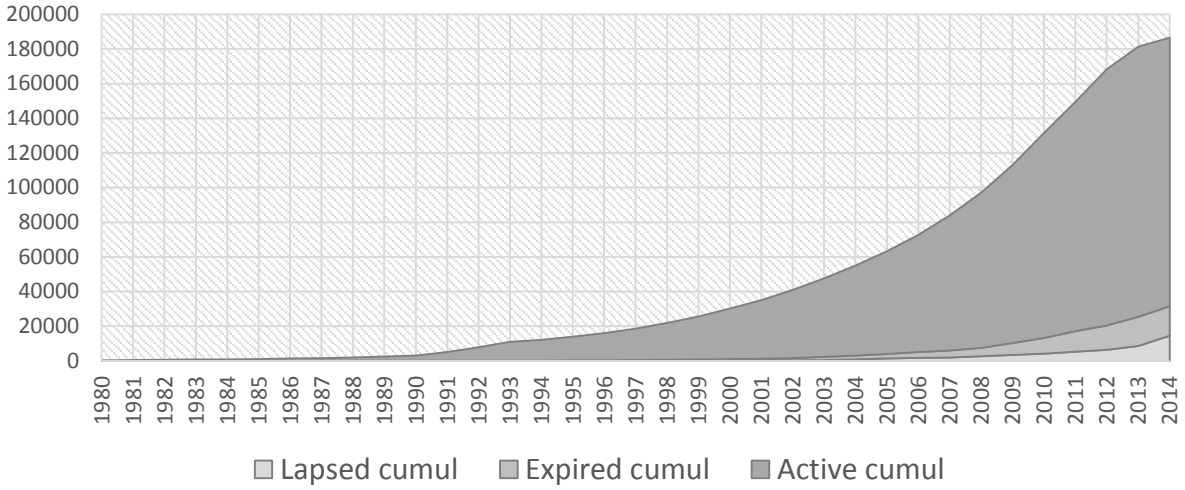

Figure 1 Cumulative number of declared standard essential patents as to patent status

Figure 2 displays the top 20 owners of portfolios of declared SEPs, counting the number of patent files and patent families. In total, we identified over 2,000 different companies declaring SEPs at the different SSOs. While there is a group of companies with a very high number of declared SEPs, we also identified a large number of companies declaring less than 10 SEPs each.

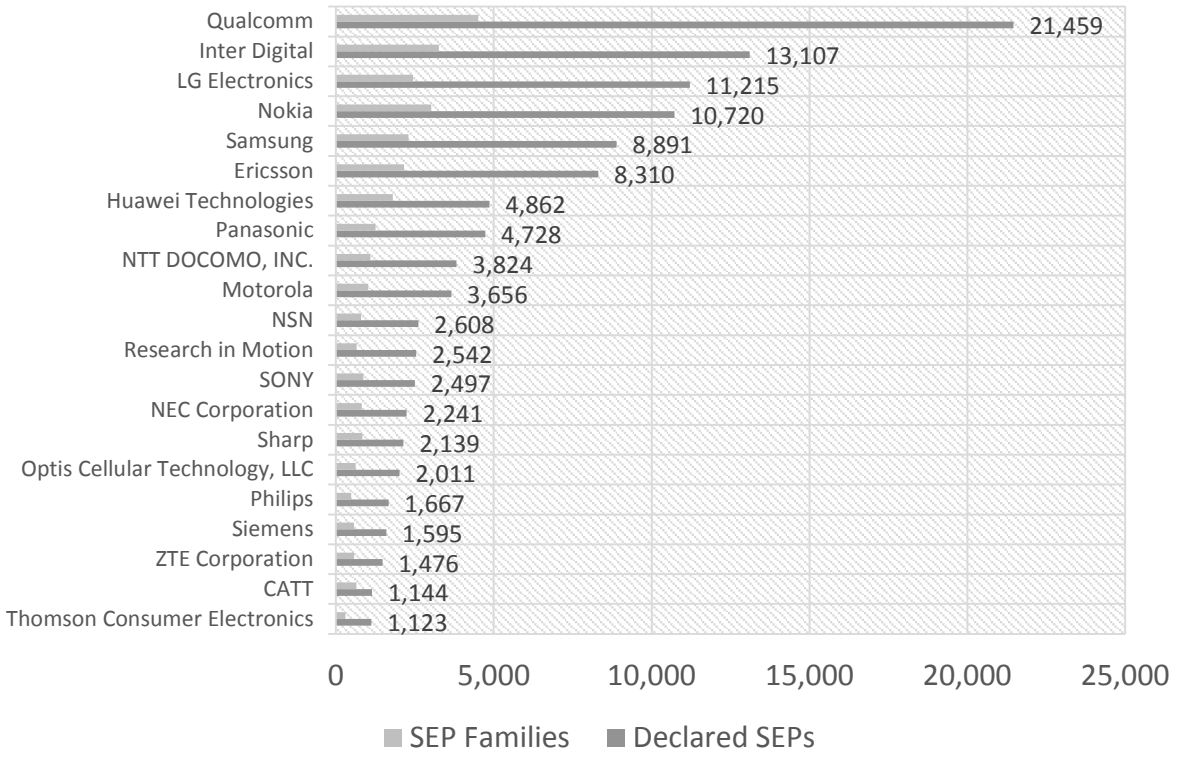

Figure 2 Number of declared standard essential patents per company (top 20)

The technological classification (CPC and IPC) of declared SEPs is an indicator for the technological area from which a standard projects draws. In figure 3 we aggregated the number of SEPs per CPC primary subclass (figure 3) to detect in which technology fields declared SEPs are classified. Wireless Communication Networks (H04W) as well as the Transmission of Digital Information (H04L) are the most frequent technology fields followed by Pictorial Communication (H04N), Information Storage (G11B) and Search Analysis (G10L).

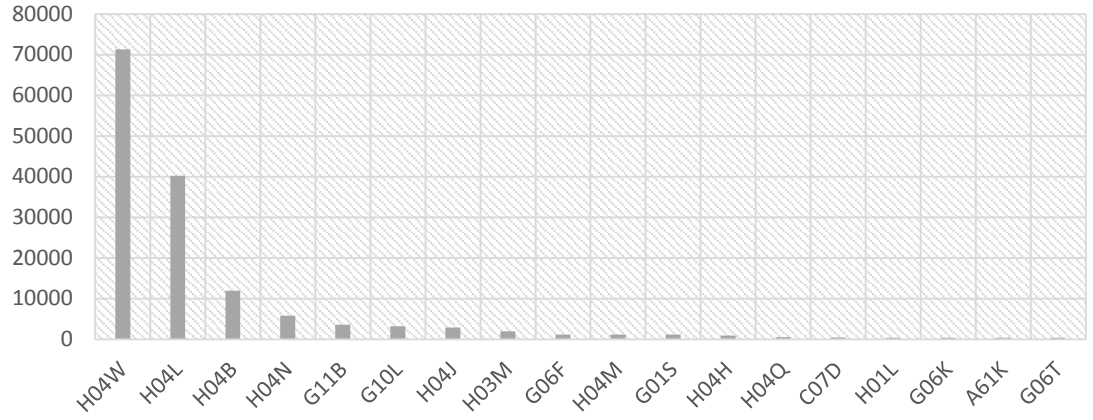

Figure 3 Number of declared SEPs as to CPC primary subclass

While the CPC classification reflects the technology space of a patent, we made use of the CPC industry concordance classification by Schmoch (2012) to relate declared SEPs to industry sectors. Figure 4 shows that most declared SEPs are classified in classes identified as relevant for the Digital Communication sector, followed by Telecommunication und Audio-Visual Technology. Similar to the CPC classification, we identify a strong concentration on the information and communication sector. In conclusion figure 3 and figure 4 show that SEPs appear to be a frequent phenomenon in coding technologies for communication sector as well as the video and audio sector.

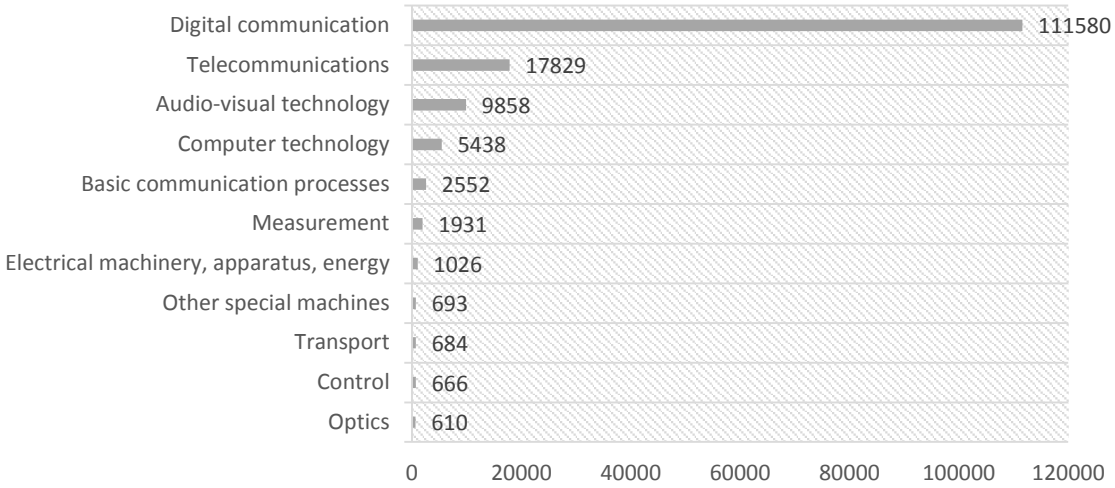

Figure 4 Number of declared standard essential patents as to industry field primary (Schmoch 2010)

In figure 5 we aggregated the number of declared SEPs by country code to identify the country of patent application. Most patents were filed in the United States followed by Japan, China and Europe. The country of publication reflects the importance of the markets for the standardized technology.

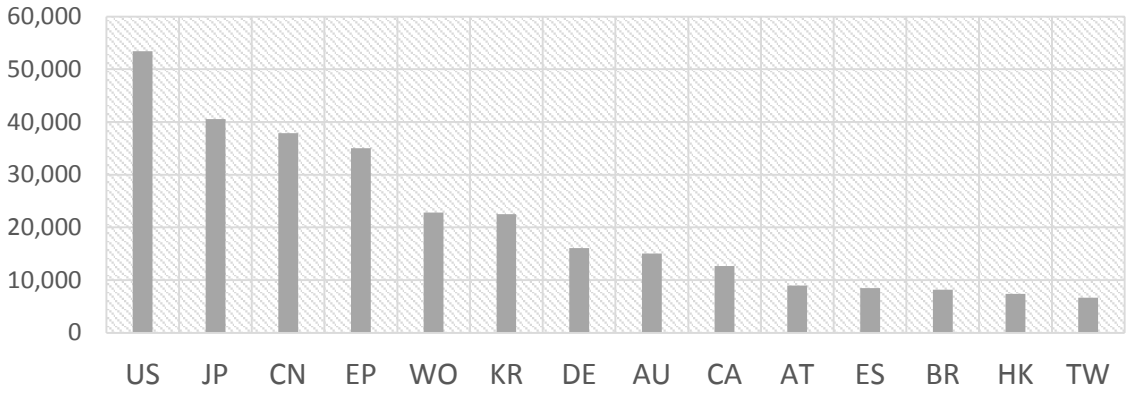

Figure 5 Number of declared standard essential patents as to country of publication

In order to compare declared SEPs with other patents, we compare the mean values of different bibliographic characteristics of patents with a control group. The control group consists in patents filed in the same country, published in the same year and classified in the same CPC primary class.

Table 3 compares the mean values of different bibliographic indicators of declared SEPs with the control group means. The results show that declared SEPs receive in average almost 4 citations, while this average value is below 3 for patents in the control group. The number of backward citations is however higher in the control group compared to declared SEPs. The surpassing number of forward citations hints to a higher technological relevance of declared SEPs, while the lower number of backward citations hints to a lower amount of patented prior art. Declared SEPs also have a much larger average family size and a higher average number of patent claims. The family size hints to a higher market coverage and thus to a higher perceived value in terms of market potential. The higher number of claims may reflect a more complex technological scope, or a larger number of useful applications per invention. Other characteristics such as the number of inventors, the number of assignees or the number of distinct IPC subclasses are not statistically significantly different.

	Declared SEPs	Control group	T-Stat
Average Forward Citations	3.927	2.875	2.345*
Average Backward Citations	6.116	7.759	2.129*
Average Family Size	87.930	56.114	4.563*
Average Number of Claim	20.885	17.787	2.348*

Average Number of Inventors	2.702	2.497	1.932
Average Number of Assignees	1.193	1.246	1.234
Average Number of Distinct IPC Subclasses	1.208	1.218	0.983
*P value is smaller than 0.05			

Table 6 Comparison of the characteristics of declared standard essential patent with control groups of patents filed in the same CPC class, same country and same publication year.

4.2. Standards Subject to Declared Standard Essential Patents

In this section, we describe the sample of standards subject to SEP declarations. We therefore matched the *standarddoc_ids* of the matched standard documents with the Searle Center Database of technology standards to retrieve additional bibliographic information. The bibliographic information on standard documents includes the identity of the issuing SSOs, the release date, the version history, equivalence of the standard document with documents issued by other organizations, references from or to other standards, and the technological classification in the ICS system.

Table 3 summarizes the number of standards of the top 11 ICS (international classification of standards) fields. The mobile communication sector is the main sector where standards are subject to SEP declarations. This is followed by the ID card, broadcasting or coding technology sector.

ICS	ICS description	Standards subject to SEPs
33.070.50	Mobile Communication	11,613
35.240.15	Identification cards and related devices	274
33.170	Broadcasting, Television and radio broadcasting	159
33.040.20	Cable - synchronization, cable systems, integrated cabling, pathways and multiplexing	104
35.040	Character sets and information coding	75
35.110	Local area networks (LAN), metropolitan area networks (MAN), wide area networks (WAN)	70
33.040.99	Other equipment for telecommunication systems	54
33.040.40	Data communication networks	53
33.160.60	Multimedia systems and teleconferencing equipment	52
33.040.35	Public Switched Telephone Networks (PSTN), Private Telecommunication Networks (PTN) and Private	40
33.070.30	Digital Enhanced Cordless Telecommunications	37

Table3 Number of standards subject to SEP per International Classification of Standards (ICS)

Standards are subject to a technology life cycle. A standard specification is often replaced by a new standard version. In such a case the preceding standard is withdrawn by the standard setting organization to ensure compatibility for the current technology vintage. Figure 6 counts the

cumulative number of standard documents subject to declared SEPs and the share of these standards that have been withdrawn. Only about one third of all standards subject to declared SEPs are still active in 2014. Compared to the number of active SEPs, this number seems to be very low. Nevertheless, new standard versions typically do not indicate obsolescence of the technology standardized in the previous version, but implement changes that are necessary to keep the existing standard up to date. Baron et al. (2013) showed that standards subject to declared SEPs are much more often updated, but much less often replaced than other standards. Figure 6 thus rather reflects the fast-moving technology development in standardization domains where SEPs matter.

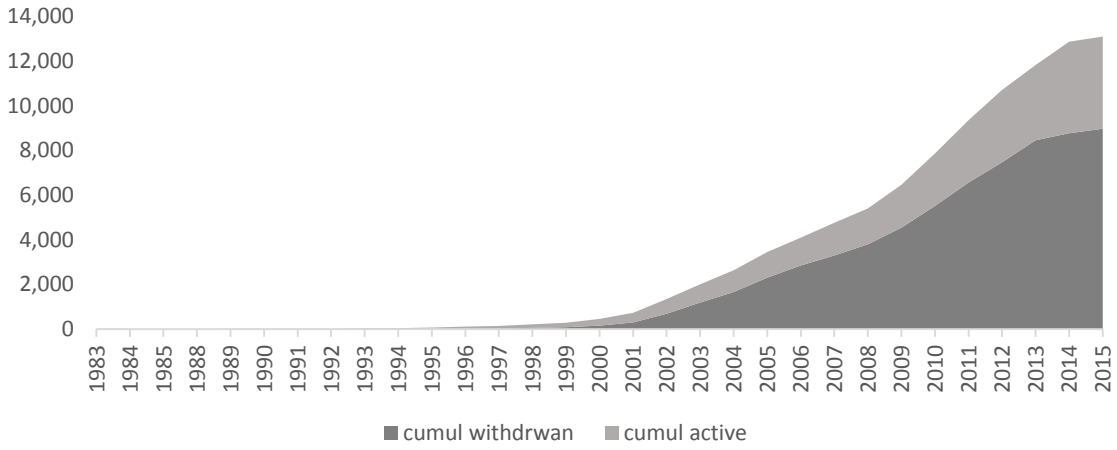

Figure 6 Number of standards subject to declared SEPs over time as to standard status

Figure 7 illustrates the number of standards publications subject to declared SEPs. The number is constantly growing and most probably only shrinks after 2012 due to truncation effects. In this regard, not only the total number of standards subject to declared SEPs is growing, but also the share of standards for which SEPs have been declared. Nevertheless, this share remains very small. In 2012 roughly 2.4% of all standards issued by one of the SSOs in our sample are subject to declared SEPs.

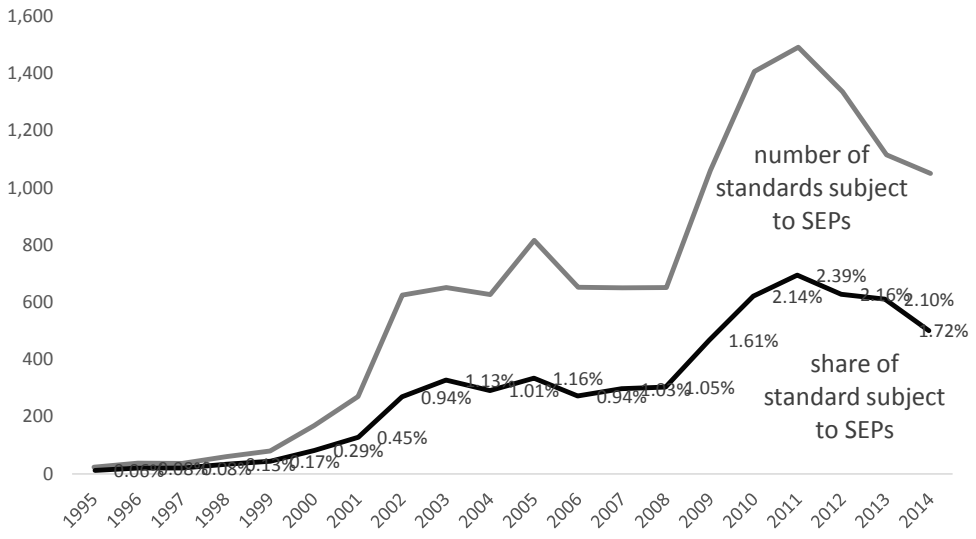

Figure 7 Number and share of standards subject to declared SEPs over time (as to publication date)

Figure 8 lists the number of standards published in total per SSO compared to the share of standards that are subject to declared SEPs. The figure shows that SEP declarations are especially concentrated on ETSI standards, where one third of the standard documents are subject to declared SEPs. In comparison, at ITU and IEEE only around 5% of all published standards are subject to declared SEPs, and at most of the other SSO the share of standards subject to declared SEPs is around 1% or below.

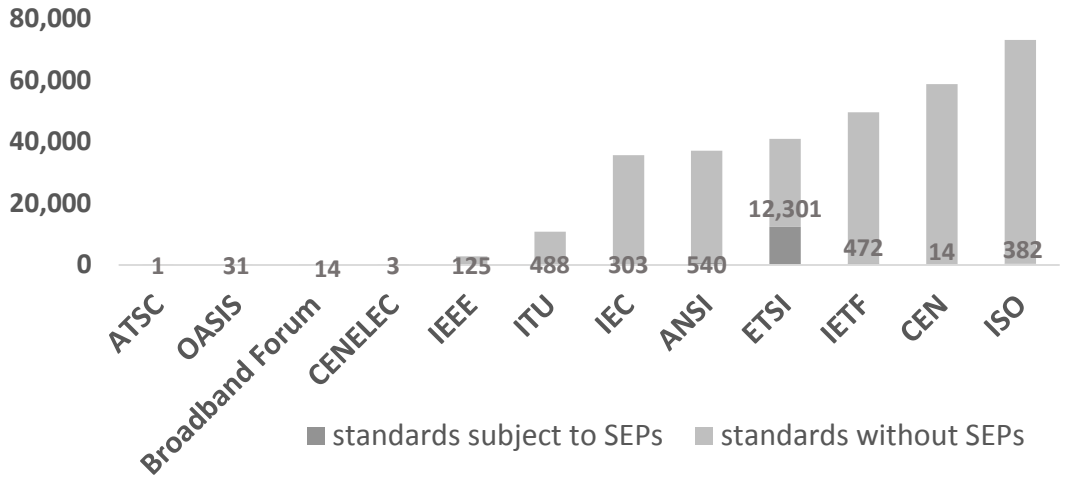

Figure 8 Number of standard documents subject to declared SEPs as to SSO

We can also calculate counts of declared SEPs per standard. We thus bundle together standard documents that share a common version history, and remove duplicates resulting from the patent being declared essential to multiple versions of the same standard. Table 4 lists the standards subject to SEP declarations by SSO and number of declarations. Declarations are counted as different combinations of patent families and declaration dates by standard.

SSO	Standards subject to declared SEPs	Standards subject to more than 10 declared SEPs	Standards subject to more than 100 declared SEPs	Standards subject to more than 1,000 declared SEPs
ANSI	27	1	0	0
Broadband Forum	14	0	0	0
CEN	17	0	0	0
ETSI	1,318	914	297	43
IEC	27	2	2	0
IEEE	98	21	3	0
IETF	275	6	0	0
ISO	113	20	4	1

ITUR	17	8	0	0
ITUT	205	35	2	0
OASIS	23	0	0	0
ANSI	27	1	0	0
Sum	2,134	1,007	308	44

Table4 Standards subject to declared SEPs, by SSO and number of declarations

Many declarations reference standardization projects which are broader than specific standards. Large numbers of declarations e.g. reference “GSM”, “UMTS” or “LTE”. These acronyms stand for complex technological systems consisting in thousands of technical specifications. We matched declarations to standardization projects, either if the project is designated directly in the SEP declaration, or if the designated standard or standard document can be matched to a standardization project. The following table lists the ETSI projects with the largest numbers of declarations. Duplicate observations resulting from a patent being declared to multiple standards that are part of the same project have been removed.

Project	Number of declarations
LTE	61,831
UMTS	43,658
UTRAN	18,757
TFTS	17,135
GSM	13,853
EUTRAN	5,175
GERAN	2,561
GPRS	2,238
DVB	1,914
SAES	1,888
TEI	1,562
TD-SCDMA	883
EDCH	769
eEurope	618
AMRWB	616
RANFS-Evo	570
GAAI	342
TETRA	331
TEI4	318

Table5 ETSI standardization projects subject to declared SEPs

Next, we compare characteristics of standards subject to declared SEPs to a control group. The control group consists in standards published by the same SSO, issued in the same year and classified in the same ICS as the standards subject to SEP declarations.

Standard documents subject to declared SEPs are referenced more often and also reference other standard more frequently. The higher number of received references indicates a higher number of technological applications implementing the standardized technology, and thus – like patent citations – signal technological relevance. The higher number of backward references indicates that standards with declared SEPs are technologically more complex, and reference a larger number of technologies that are necessary for their implementation. A higher number of normative references also points to a lower degree of flexibility in choosing methods for implementing a standard. Higher flexibility in standard implementation reduces the scope for both normative references and SEPs. Standard documents subject to declared SEPs also have a higher number of international accreditations, indicating a larger geographical reach, or alternatively documenting support from a larger number of organizations. Standards subject to declared SEPs have a higher number of pages, suggesting that these standards are more complex. Standard documents subject to SEPs also belong to version histories including a higher number of versions, illustrating a higher standardization activity and shorter standard live cycles. The number of distinct ICS counts and the number of keywords is similar to the control group.

	Standards subject to SEP declarations	Control group	T-Stat
Average Forward References	4.108	3.281	2.342*
Average Backward References	14.674	10.044	3.986*
Average Number of Accreditations	3.105	2.712	2.192
Average Number of Pages	186.631	131.267	3.345*
Average Standard Versions	8.531	6.012	2.897*
Average Distinct ICS Count	1.020	1.019	0.523
Average Number of Keywords	9.650	9.902	0.916
*P value is smaller than 0.05			

Table 7 Comparison of the characteristics of standards subject to SEP declarations with control groups of standards filed in the same ICS class, same country and same publication year.

4.3: Standard-related patenting

Patenting over the standard lifetime

In order to analyze how reliably this method identifies patents that are technologically related to specific standards, we analyze how the intensity of patenting evolves over the standard lifetime. Table 8 provides the results of an econometric analysis of 2,576 different standard documents. For each standard document, we calculate the weighted count of standard-related patent applications per year, and relate this count to the age of the standard document (defined as the number of years up to or since publication of the document). The analysis reveals that, controlling for standard document and year fixed effects, the number of patent applications significantly decreases with the distance in time from the publication date of the standard document.

OLS fixed effect regression			Obs	42,828
			Groups	2,576
Related patenting	**Coeff.**	**Std.Err**	**t-statistic**	**Pr > |t|**
Standardage_sq	-0.18894	0.02465	-7.67	0.0000
Year& standard fixed effects	Included but not reported			
Constant	48.5593	9.4277	5.15	0.0000

Table 8 Fixed effect linear regression regression: standard-related patenting over standard age

These results indicate that patenting in the technology classes of declared Standard Essential Patents correlates with standard development. This is remarkable, given that we consider all worldwide patent files, and do not restrict the counts to firms that have declared SEPs or otherwise participated in standard development. Using the CPC classification, we can thus detect standard-related patents that are not subject to declaration obligations, and construct measures of standard-related patenting that are relatively independent of the strategic incentives to declare SEPs.

5. Research outlook

The present database provides manifold opportunities for novel empirical research. The phenomenon of declared SEPs is a subject of considerable policy relevance and draws an increasing amount of academic interest. Many observers point to the rising number of SEP declarations as a subject of concern; but the policy debate and the economic literature are still insufficiently informed by empirical data. In particular, there has been no database of declared SEP matching observations of declared SEPs with technology standards. Empirical scholars have so far focused on the match between SEP declarations and patent databases, e.g. to study the characteristics of declared SEPs, and how declared SEPs evolve after the disclosure.

The new database updates and significantly expands available data on SEPs, and furthermore carries out a careful matching between declared SEPs and technology standards on the level of the standard version, standard and standardization project. This matching enables analyzing also the standard side of SEP declarations. Using large-scale databases of technology standards, economists can investigate how standards subject to SEP declarations differ from other standards. We provided preliminary empirical evidence suggesting that these standards are more complex, include a larger number of normative technological requirements, and have a larger number of technological applications. While large strands of the existing empirical literature focus on strategic motives for patenting and declaring SEPs, these results put the evidence on SEPs into the context of the development of increasingly complex and interdependent technology standards. Systematic empirical research on standards using the data presented in this paper may advance our understanding of the underlying economic and technological forces driving the increase in the number of SEP declarations, and shed a different light than studies focusing exclusively on the patent side.

In addition, the new database may also shed light on the consequences of SEP declarations for standard development and adoption. Several observers caution that standards subject to large numbers of declared SEPs are at risk of getting stuck in *patent thickets*, stifling the technological progress and severely slowing down the adoption of these standards. No empirical evidence however exists that would corroborate these widespread concerns. Preliminary statistical evidence based on the present database suggests that standards subject to SEP declarations experience more frequent version changes, are referenced more often by other standards, and are accredited by a larger number of SSOs. While thorough econometric analysis is required to support causal claims, these observations seem at odds with the claim that SEP declarations are a serious threat to the technological progress and implementation of technology standards.

We have stressed the importance of distinguishing between the empirical sample of declared SEPs and the unobservable group of patents that are actually necessarily infringed by any implementation of a standard. Furthermore, SEPs only constitute the tip of the iceberg, as many more patents are related to technology standards. While the group of patents related to specific standards is difficult to observe, we suggest that the CPC classification of declared SEPs may be used to identify technology classes in which patents are more likely to be standard-related. Using this matching between standards and CPC classes, empirical researchers can study the effect of standardization and specific events affecting a standard on the extent and characteristics of standard-related patenting.

Data on standard-related patents and CPC classes is also of interest for identifying complementary or potentially complementary technologies. The CPC and other technological classifications of patents classify patents by the technological and scientific field of the invention, but do not identify patents that are relevant for similar or related uses. Standards often involve inventions from many different scientific and technological fields, and thus characterize relevant combinations of very different, yet complementary methods. Furthermore, the ICS classification of standards classifies standards by field of use, and allows identifying different standards with similar uses. A mapping of standards to CPC classes can thus shed light on fundamental questions in innovation economics: how do firms coordinate inventions in complementary research fields? How do firms select and combine technical methods (e.g. through standardization) for a specific use? How does patenting and technological progress in one technological field affect complementary or substitute technological fields?

Finally, the mapping of standards or standardization projects to CPC technology classes can be extended to entire classes of standards (e.g. in the ICS classification of standards). Such a mapping between different systems of technological classification allows studying the interdependence between patents (new inventions) and standards (selection and adoption of specific methods).

While the current mapping of standards to CPC technology classes provides a useful input for a broader concordance between the different systems of technological classification of patents and standards, data on declared SEPs needs to be complemented with other sources of information. SEPs are concentrated in specific technological fields, and represent a very particular relationship between patents and standards. Complementary insights can e.g. be gained from studying patents citing standard documents as prior art in the Non-patent literature (NPL).

6. Conclusion

We have described a new database of declared SEPs, and discussed the methodological challenges for the use of databases of SEP declarations in economic research. The database we describe is the most up-to-date and comprehensive database of declared SEPs, and it is the first such database matching SEP declarations to standard documents on the level of the standard version, standard and standardization project. In combination with the *Searle Center Database of Technology Standards and Standard Setting Organizations*, this database allows addressing important research questions at the intersection between technology standards and patents. A growing body of economic research has analyzed the role of SEPs, and has influenced policy makers and practitioners who advocate important changes to the procedures and IPR policies of SSOs. Nevertheless, the current debate is still insufficiently informed by empirical evidence on the economic drivers and consequences of SEP declarations.

Reaching far beyond the current interest in SEPs; matching standards with patents and classes of patents opens up opportunities for new research that will enhance our understanding of technological innovation. The invention and the coordinated selection of new technological methods interact in generating technological progress in increasingly complex and interdependent technological systems. A systematic concordance table between systems of technological classification for patents and standards can be a powerful tool for research on this interplay. The technological classification of declared SEPs provides valuable information supporting the establishment of such a concordance table. Ongoing research will extend the methodology to other patents related to technology standards, e.g. patents citing standard documents as prior art, in order to include larger technological areas and cover more diverse relationships between standards and patents.

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Appendix

Appendix 1: Tabular overview over the database

SCDB_Letter.dta					
Variable name	**Label**	**Format**	**Number obs.**	**Unique obs.**	**Connects with**
letter_id	disclosure letter id	str244	8,527	8,527	SCDB_Decl_Standard_des, SCDB_Decl_Patent
declaration_date	DD.MM.YYYY	str10	8,527	3,113	
company_name	declaring company (harmonized name)	str239	8,527	3,015	SCDB_firm_names.dta
sso	Name of SSO to which declaration was made	str37	8,527	19	SCDB_sso_names.dta

SCDB_Decl_Patent					
Variable name	**Label**	**Format**	**Number obs.**	**Unique obs.**	**Connects with**
letter_id	disclosure letter id	str244	199,694	8,527	SCDB_Decl_Standard_des, SCDB_LoA.dta
patent_number	patent application or publication number	str18	195,187	122,413	PATSTAT
inpadoc_family_id	patent family ID	str24	191,276	28,201	PATSTAT

SCDB_Decl_Standard_des					
Variable name	**Label**	**Format**	**Number obs.**	**Unique obs.**	**Connects with**
letter_id	disclosure letter id	str244	31,780	8,527	SCDB_Decl_Patent, SCDB_Letter.dta
standard_designation	designated standard as to disclosure letter	str244	31,780	10,422	SCDB_Decl_Project, SCDB_Decl_standarddoc.dta

SCDB_Decl_Project					
Variable name	**Label**	**Format**	**Number obs.**	**Unique obs.**	**Connects with**
standard_ designation	designated standard as to disclosure letter	str48	7,770	5,351	SCDB_Decl_Standard_des
standard_project	ETSI/3GPP standardization project	str18	7,770	87	SCDB_standards_CPC_mapping.dta

SCDB_Decl_standarddoc.dta					
Variable name	**Label**	**Format**	**Number obs.**	**Unique obs.**	**Connects with**
letter_id	disclosure letter id	str172	38,495	5,813	SCDB_Letter.dta, SCDB_Decl_Patent
standard_designation	designated standard as to letter	str194	38,495	8,050	SCDB_Decl_Standard_des, SCDB_Decl_Project
standarddoc_id	AC code or other unique standard document ID	str10	38,495	23,191	**SCDB_Standards.dta; PERINORM**
unique	declaration uniquely identifies standarddoc	byte	38,495	2	
vlevelmatch	matched on version level	byte	38,495	2	
slevelmatch	matched to version or standard (current version)	byte	38,495	2	
slevelmatchinclfoll	matched to version or standard (current and following versions)	byte	38,495	2	

SCDB_standards_CPC_mapping.dta					
Variable name	**Label**	**Format**	**Number obs.**	**Unique obs.**	**Connects with**
standard_or_project	standarddoc_id, standard_project or unmatched designation	str244	590,190	3,213	SCDB_firm_patenting.dta
standarddoc_id	AC code or other unique standard document ID	str10	441,686	1,854	SCDB_Decl_standarddoc.dta**,SCDB_standard_documents.dta; PERINORM**
standard_project	broad standardization project	str118	62,104	78	SCDB_Decl_Project
ipc_class	12 digit IPC/CPC class	str14	590,190	18,953	**PATSTAT**
tot_weight	relevance of class to standard	float	590,190		
tot_weight_standard	Number of SEPs used for mapping	float	590,190		
tot_weight_class	Prevalence of class in sample	float	590,190		

SCDB_firm_patenting.dta					
Variable name	**Label**	**Format**	**Number obs.**	**Unique obs.**	**Connects with**
standard_or_project	standarddoc_id, standard_project or unmatched designation	str244	860,541	3,208	SCDB_standards_CPC_mapping.dta
standarddoc_id	AC code or other unique standard document ID	str10	661,289	1,854	SCDB_Decl_standarddoc.dta**,SCDB_Standards.dta; PERINORM**
standard_project	broad standardization project	str118	31,814	78	SCDB_Decl_Project
company_name	harmonized firm name	str72	860,541	190	**SCDB_firm_names.dta**
year	Calendar year (priority)	int	860,541	48	
tot_patenting	Number of priority appln. by firm, weighted by tot_weight	float	860,541		
tot_patenting_cw	tot_patenting weighted by forward citations	float	860,541		