Standard Essential Patents and the Distribution of Gains from Trade for Innovation

Florian Ramel[*]
Maximilian von Laer*
Knut Blind*[†‡]

Think piece for the *Mega-Regionalism – New Challenges for Trade and Innovation* workshop

held at the
East-West Center, Honolulu, Hawaii

January 20 & 21, 2016

Abstract: An earlier study finds that standard-essential patents (SEPs) enhance trade and additionally lead to a phenomenon of global cross-licensing, i.e., global value chains (GVCs) arise along those countries in which companies will act as both licensor and licensee of SEPs. This, however, simultaneously leads to the situation that SEP-induced GVCs are a relatively closed-off club of companies that profit from the artificial temporary monopoly awarded by patents and their connection to standards. The paper proposes several paths for future research with the goal to uncover the micro-mechanisms of these findings. The principal questions asked are (1) How can intermediate producers (i.e. global network suppliers for instance in Korea and China) profit from GVCs in which many SEPs are used? (2) How is upgrading (i.e. moving up in the GVC towards performing more elaborated tasks) in an SEP-induced GVC possible? (3) How can a company reach a position that allows it to exert control over a GVC?

Keywords: Standard-essential patents, global value chains, upgrading, standardization, intellectual property rights

[*] Technische Universität Berlin, Chair for Innovation Economics, Sekr. MAR 2-5, Marchstr. 23, 10587 Berlin, Germany
[†] Fraunhofer Institute of Open Communication Systems, Kaiserin-Augusta-Allee 31, 10589 Berlin, Germany
[‡]Chair of Standardisation, Rotterdam School of Management, Erasmus University, Burgemeester Oudlaan 50, 3062 Rotterdam, Netherlands

1 Introduction

Formal standards provide specifications of technologies. They are developed by industry representatives and are then openly available for use by anyone. In many ways, they fulfill the definition of a public good[1]: The use of a standard is non-rivalrous (i.e. it can be used by an unlimited number of actors simultaneously) and non-excludable (i.e. no one can be barred from using it). Standards therefore serve to diffuse technologies in the markets (Blind 2004).

Patents also provide specifications of technologies. Yet they work very differently from standards. Patents grant the patent holder the exclusive right to use their protected technology during the duration of the patent grant. Because patents grant this excludability and are simultaneously rivalrous in their nature (there can only be one patent of a kind, never two identical ones), they can be characterized as private goods. Patents thus give the patent holder a competitive advantage over their competitors. Nevertheless, patents facilitate the diffusion of technologies because patent holders can license the right to use the protected technology to other market actors (Blind et al. 2006; Blind et al. 2009).

In recent years, a new factor has come into play that combines standards and patents: standard-essential patents (SEPs; Lerner and Tirole 2015). When a standard implements a patented technology, the standard-setting organization (SSO) needs to ensure that everyone who is going to use the standard will receive a license from the patent holder in order to be able to do so. The patent then becomes standard-essential and the respective licenses usually adhere to so-called FRAND (fair, reasonable, and non-discriminatory) terms. SEPs have mainly emerged in the ICT (information and communication technology) sector because standards in this area often implement hundreds or thousands of patented technologies. Examples are the standards used in smartphones, or in technologies such as UMTS or MPEG. Due to the ongoing digitization and interconnectedness, other sectors like automotive or household appliances are also starting to be affected by SEPs (Bekkers et al. 2014). SEPs play a major role in many court cases and “patent wars” between large ICT firms. They have therefore not only aroused big research interest but also have significant economic impact (e.g. Bekkers et al. 2011; Bekkers et al. 2014; Blind et al. 2011; Pohlmann et al. 2015).

Another development in the global economies concerns the way production takes place. One product or service is not necessarily produced in a single factory or within one country anymore. There is a clear shift towards production in global value chains (GVCs), i.e. a product or service is completed in several production stages in multiple countries (Baldwin 2013). In the course of production, intermediates are shipped from one country to another. The geographical length of GVCs, the number of stages that are used to produce a single item, and the number of countries involved in a single GVC have all increased over the last two decades (Miroudot and Nordström 2015).

With a surge in SEP disclosures to SSOs, the first usable time series of SEP data are now becoming available. At the same time, new ways to measure global trade allow to map the actual flow of goods, intermediates, and services in GVCs. This availability of new data

[1] The reader is referred to the debate about the public good character of standards. Standards combine aspects of public as well as private goods. To name only a few, Berg (1989) highlights the external effects that the adoption of a standard by a firm can have on the market and the acceptance of a standard while Garcia and St. Clair (1992) call standards “impure public goods” (p. 9) as they can be produced privately and serve a private purpose but still improve public welfare.

allows us to test the influence of SEPs on GVCs for the first time, i.e. to find out how SEPs affect the layout of global production patterns.
In the next section, we discuss our empirical results in detail. We find that SEPs enhance trade and additionally lead to a phenomenon of global cross-licensing, i.e., GVCs arise along those countries in which companies will act as both licensor and licensee of SEPs. This, however, simultaneously leads to the situation that SEP-induced GVCs are a relatively closed-off club of companies that profit from the artificial temporary monopoly awarded by patents and their connection to standards. In section 3, we propose further avenues for research. Especially a focus on the microeconomic impacts of SEPs that helps to explain who will succeed under the new circumstances seems to promise useful results. Section 4 eventually concludes with recommendations for the next steps to take.

2 The macroeconomics of SEPs – first insights

Our dataset provides us with a list of the patents that were disclosed to SSOs as being standard-essential from 1990-2010.[2] From the data we construct an SEP stock variable for the years 1995, 2000, 2005, and 2008 (we are restricted to these years because of the limited coverage of the matching trade data). The SEP stock is the stock of patents of a country that were disclosed to an SSO as being standard essential until the end of the given year.[3]
From the descriptive statistics of the SEP stock variable we see that it has risen sharply during the observed time frame from less than 500 in 1995 to almost 20.000 in 2008, which underlines the notion of a surge in SEP disclosures. In addition, there are enormous differences in the SEP stocks between the different countries, i.e. there are some countries that hold no or only a few SEPs whereas other countries hold many. The countries whose SEP stocks are above the third quartile of all SEPs in the sample in 2008 are China, Germany, Japan, South Korea, and the United States (in alphabetical order).
In order to assess the GVCs, we use trade in value-added data. These data allow us to see how many inputs (raw materials, intermediates) a country imported, how much value its domestic producers added to these inputs, and how much of the value-added was eventually exported to the next country in the GVC. We restrict the data sample to the ICT sector because SEPs are only really prevalent in this industry (Bekkers et al. 2014).[4]

2.1 Results from an earlier empirical study

In order to identify the effects of SEPs on GVCs, we use a so-called gravity model of trade (Anderson 1979; Anderson and van Wincoop 2003; Deardorff 1998; Tinbergen 1962). This model allows us to estimate the effects of SEPs on trade in value-added while we control for a number of other effects that might affect the trade flows: geographical distance, cultural similarities between the countries, idiosyncratic effects of certain years or countries, or the effects of patents and standards (see Ramel and Blind (2015) for the full model).

[2] The data are kindly provided by IPlytics GmbH.
[3] There are 20 countries in the sample: Austria, Belgium, Brazil, China, Denmark, Finland, France, Germany, Italy, Japan, South Korea, Netherlands, Poland, Russian Federation, South Africa, Spain, Sweden, Switzerland, United Kingdom, United States.
[4] Our trade data covers the ISIC Rev. 3 classes 30-33: Manufacture of office, accounting and computing machinery, electrical machinery and apparatus n.e.c., radio, television and communication equipment and apparatus, medical, precision and optical instruments, watches and clocks.

We present the stylized trade effects from the estimation for the most relevant variables in the following paragraphs. Firstly, for reference, we report the effects of patents with no reference in standards on trade flows. They enhance exports because of the competitive advantage they grant, and decrease imports because patent holders produce a superior technology so that no imports of other, inferior technologies are necessary. This result is in line with former research (e.g. Anderton 1999; Blind and Jungmittag 2005; Greenalgh et al. 1994).

Although SEPs are patents as well, the estimation results differ in case of the SEP variable. They show an overall trade enhancing effect, yet in contrast to "regular" patents, the effect is also positive on the importer side. The positive coefficients for both exporting and importing countries are an expression of cross-licensing between domestic and foreign companies. Cross-licensing originally refers to the "preferred means by which large companies clear blocking patent positions amongst themselves" (Shapiro 2001, p. 129). In the ICT sector, companies are technologically interdependent. Patent thickets, i.e. technologies in which many different patents overlap, are very common (Bekkers et al. 2014; Graevenitz et al. 2011, 2013). In addition, ICT innovations are often cumulative, i.e. they build upon each other (Bessen and Maskin 2009). Former research shows that under these circumstances cross-licensing is common (Nagaoka and Kwon 2006; OECD 2013; WIPO 2011) and that it is especially typical in the realm of SEP-referencing standards (Bekkers and Martinelli 2012).

The cross-licensing thus allows the producers to use all technologies they need, including those that require licenses from competitors. SEPs thus play an important role in supporting GVCs, in which intermediates are exchanged equally back and forth in order to combine them into a standardized product. Hence they have a positive effect on trade in both directions.

The close intermingling of producers in the GVCs may, however, also have a downside. SEP-induced GVCs are a relatively closed-off club of companies. Once a standard that implements SEPs is published, this technology is locked in and all SEP holders in the standard enjoy a temporary monopoly. SEPs would then act anti-competitively (Lerner and Tirole 2015) and become an antitrust issue like patent pools that are suspected to provide a platform for collusion (Farrell et al. 2007; Lerner and Tirole 2004). The pools are suspected to create monopolies that complicate the integration of outsiders into production flows that require licenses from SEP holders. Moreover, through the standard, patent pools can be used to lock in a certain market for the involved companies ensuring safe and potentially long-term profits (Choi et al. 2004; Shapiro 2001). This kind of licensing strengthens the relationships between the involved firms and increases the market power of the incumbents (Choi et al. 2004; Grindley and Teece 1997).

We try to grasp this issue with the use of a third variable, a multiplicative interaction term between the SEPs and the stock of national standards in a country. National standards are known to constitute barriers to trade because they cause high adaptation costs for foreigners (Blind 2004). If a country now has a large stock of national standards and at the same time a large stock of SEPs, we assume the protectionist momentum to be so strong that the negative effects for outsiders predominates the positive effects for the incumbents. Testing this empirically, we indeed find the trade effects to be negative, i.e. the larger the combined stock of national standards and SEPs in a country is the more trade decreases. This seems to provide first empirical evidence for our assumption.

The patterns that we present lead to further implications and questions that need to take into regard the industry structure of the GVCs.

2.2 SEP disclosures and the GVC position of countries

The data we use contain 378,003 patents that were disclosed as standard-essential. It is noteworthy that as shown in Table 1 the two companies that engage in disclosing SEPs most heavily account for almost half of all the disclosures of 1155 companies in total. The six most actively disclosing companies account for almost three quarters of all disclosures.

Table 1: Descriptive statistics of SEP disclosures by company (total until 2014).

	InterDigital	Qualcomm	LG Electronics	NOKIA	Ericsson	Motorola	Remaining 1149 companies
SEP disclosures	87437	84890	46657	29444	19338	14556	95681
% of total disclosures	23.13	22.46	12.34	7.79	5.12	3.85	25.31
			74.69				25.31

Source: IPlytics GmbH (authors' calculations)

We see that there is indeed a very small group of firms that control the majority of SEPs. This industry structure certainly supports the notion of a club when describing the market actors involved with SEPs. On the one hand, it is easier to reach an agreement about cross-licensing when fewer players are involved in the negotiations, which in turn facilitates the creation of GVCs that rely on SEPs. On the other hand, with so few players involved, these can easily construct high barriers to market entry for outsiders. This leads back to the notion of pools exhibiting cartel-like structures.

An immediate eye-catcher when regarding Table 1 is that the two leading SEP disclosers are non-manufacturing companies. InterDigital and Qualcomm pursue business models that are based on developing, licensing, and trading IPR. Especially with a regard to GVC the question arises if there is a separation between the IPR-developing and IPR-trading companies, and the manufacturers.

Even though the majority of SEPs is controlled by only a few SEP holders, there are many more market actors such as subsidiaries, independent producers, procurers, wholesalers, retailers etc. involved in related GVCs. All of these companies are part of the production, service, and distribution network yet none of them hold SEPs. Dedrick et al. (2010) analyze the GVCs of the production of iPods and notebook PCs as an illustrative example of this fact. They find that there are numerous companies in several countries involved in manufacturing these products. Only the enterprises on the very top of the value chain, those that provide the product designs, labels, brands, and overall coordination of the process hold the SEPs or the licenses.

The fact that SEP holders can influence the layout of a certain GVC but need the support of companies on lower levels of the chain to make the final products generates externalities. Manufacturing companies, e.g., naturally want to profit from being part of a GVC. In order to support such firms, some countries actively make policy decisions to facilitate entry into

GVCs. Especially emerging economies see GVCs as one way to foster their economic development and to engage in global markets. Brazil, e.g., deliberately tried to strengthen its consumer electronics industry so to become one of the major global manufacturers in this sector. A "picking" of certain GVCs by governments to get involved in can then, as in Brazil, lead to economic success. Nonetheless, as a mere manufacturer with no innovative activity of its own, it will be difficult to move up in the GVC and to steer and control it eventually (Gereffi and Sturgeon 2013).
In the next chapter we discuss the aspects for future research that emerge from these considerations.

3 Aspects for future research

The principal thoughts that we stress in this section can be summarized as follows:

- There is a strong oligopolistic structure in the SEP-related businesses. Still, the gains from these GVCs are shared between the SEP holders and those companies that do the manufacturing but do not hold SEPs themselves.
- China, e.g., as an emerging economy, has managed to become one of the major SEP holders because government action focused on fostering generic growth in R&D. Other emerging economies, such as Brazil, have positioned themselves as mere manufacturing countries in the SEP-induced GVCs and struggle to achieve generic growth of other domestic markets outside of mere ICT manufacturing.
- The actual microeconomic flows of trade in value-added together with a disaggregated look at where SEPs are actually being invented are a promising avenue for further research. Detailed and more disaggregated data will be increasingly available to pursue this track.
- The disclosure of SEPs is concentrated in European, international, and US-based SSOs and consortia. Other countries seem not to be able to attract SEP holders into their standard setting bodies.
- Investigating who participated in the standard setting of standards that reference SEPs will allow drawing a more nuanced picture of the mechanisms at work.

3.1 Upgrading via SEPs and the role of government policy

The empirical facts lead us to a first interesting question for further research: How can intermediate producers profit from GVCs and how is upgrading (i.e. moving up in the GVC towards performing more elaborated tasks) in an SEP-induced GVC possible? In a further step, the question would extend to: How can a company reach a position that allows it to exert control over a GVC?
Generally, adhering to the standards of a GVC is seen as essential for upgrading (Gereffi et al. 2005; Kaplinsky 2010; Nadvi 2008). Especially in SEP-induced GVCs this seems intuitive because the final product is heavily standardized. Only adhering to standards will, however, not result in upgrading. A company that wishes to upgrade must be able to fulfill the requirements that are needed on a higher level in the GVC. These requirements will be reached through success in business and the subsequent possibilities to grow (Nadvi 2008). Especially when businesses have first access to GVCs because of government actions, it

might be difficult to achieve this kind of generic growth. Whenever government actions strengthen a specific part of the economy, this very part usually grows whereas the surrounding sectors and markets stay at the same level or may even decrease in strength because of the new allocation of resources (Gereffi and Sturgeon 2013). Therefore, a policy-driven top-to-bottom approach at first sight appears not be the right path to move domestic companies up in GVCs.

Upgrading in GVCs will rather be achieved whenever a company shifts from being a standard taker towards being a standard setter. Research about developing countries shows successful upgrading when representatives of these countries actually take part in the standard setting at SSOs and influence the standards in a way that the domestic innovations of the respective country become part of the standard (Kang and Motohashi 2015; Nadvi 2008). However, as we regard the special case of SEPs, becoming a mere standard setter does still not suffice to play a major role in a GVC. Referring back to the results from the trade data, we realize that only those companies that actively engage in cross-licensing shape GVCs. Therefore, in order to gain such a position, companies need their own patents as bargaining chips in standard setting. Without these, they are unlikely to receive the licenses from other firms that they need to be able to play a crucial role in the GVCs. This gives a first answer to the second question we posed.

Obtaining own SEPs, however, require heavy investments in R&D that can generate outputs that will actually be regarded as standard-essential. Generally, this kind of R&D is driven by companies that are already experienced innovators. For this reason it is especially difficult for companies that are laid out as manufacturers in a GVC to construct and manage R&D departments that produce the required output. Only generic growth of a company as we mentioned it above is likely to result in such R&D. However, there is empirical evidence in our data sample that it is also possible for emerging countries to become an important player in GVCs. In section 2, we describe which countries hold the majority of SEPs in 2008 (China, Germany, Japan, Korea, United States). In 1995, the top five countries were Germany, United Kingdom, Japan, Sweden, and the United States. China and South Korea thus managed to move up into this top five group within 13 years.

Kang et al. (2014) investigate this development and point out that it is the result of two separate strategies. The authors show that South Korea relied on technology transfer from leading countries that hold the majority of SEPs such as the United States and applied these technologies successfully. The country was therefore a typical standard taker, yet has managed over time to learn from the inflowing innovations and to build her own technological strength with own SEPs. Kim (1997) investigates for the case of South Korea how capability formation by acquiring, assimilating and improving foreign technologies by domestic firms can take place in developing economies. The author confirms that South Korea could create generic growth because it was able to profit from being a developed country in general and from having a number of powerful domestic incumbents such as Samsung, LG etc.

The case of China is, however, very different. Instead of fostering the import of technologies, local governments can alternatively bring forward the indigenous R&D in their countries with the goal to reach higher levels in the GVCs. This strategy is actively pursued by China, e.g. by establishing a sophisticated culture of national standardization (Ernst 2011a, 2011b).

Especially in SEP-related fields, China developed her own technologies and SEPs. As Kang et al. (2014) note, this is only possible because of the enormous size of the internal Chinese market. The internal market creates a sufficient amount of demand for Chinese technology products so that domestic standards can survive economically. After years of successful domestic development, the Chinese industry is now savvy enough to be able to produce SEPs of international interest. China, therefore, pursued a successful policy-induced path which was eventually successful thanks to perseverance and a large domestic market.

Although the cases of South Korea and China are certainly more complicated in reality, these findings show in a nutshell that there are different, very specific ways to success and that one of these ways may actually be a strong top-to-bottom approach. Because of the competition and high entry barriers in SEP-related markets it proves therefore to be difficult to upgrade in these GVCs without concentrated government actions combined with the right business environment. Still, SEPs seem not to be very prominently placed on the political agendas. While the European Commission and the U.S. Department of Justice have published statements regarding litigation and antitrust issues (European Commission 2014, 2015b; U.S. Department of Justice and U.S. Patent & Trademark Office 2013), we do not know of any government policy concerning the fostering of SEP development at local companies at this point. Given the economics of SEPs, a political program concerning SEPs similar to, e.g., the Chinese national standardization strategy, would be a promising step. Such a program should be supported by future research looking into microeconomic time series data that cover the involvement of specific companies in the SEP-induced GVCs and that ideally indicate SEP-related government policy actions as well.

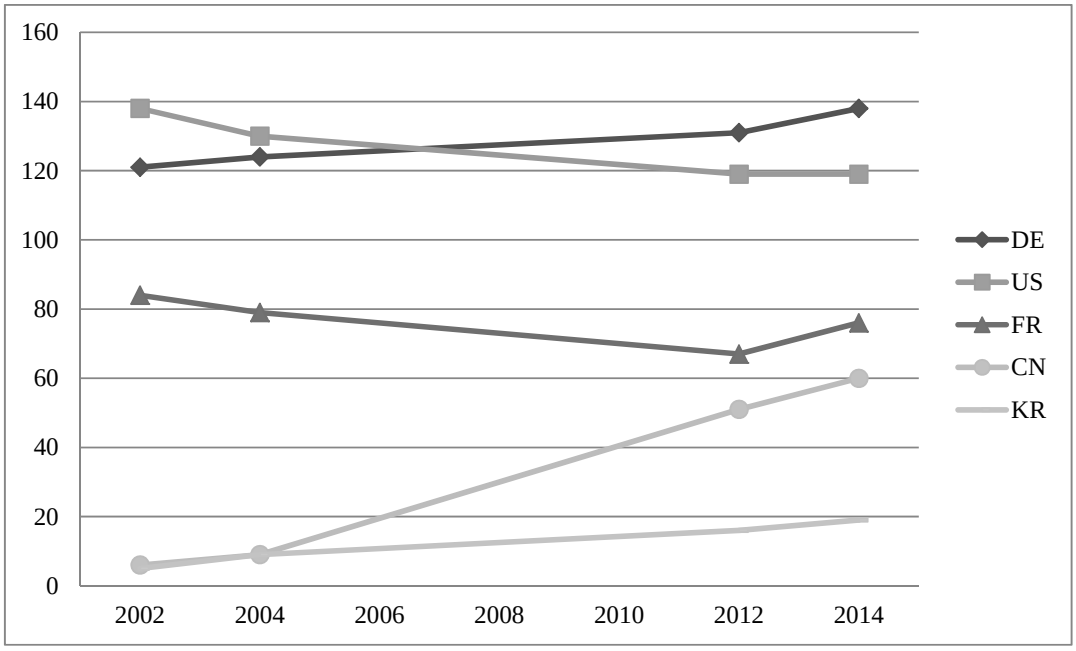
The data we have available at the moment show clearly that the SEP-heaviest market actors are few and are indeed very heavy. Consequently, the question arises if and how a smaller company, even if it succeeds in developing SEPs, can become influential in this market with holding only a few SEPs. A simple solution would be to sell the SEPs off to one of the major players that hold patent portfolios. In this case, the oligopolistic structures would be strengthened. Otherwise, companies have to try to build their own SEP portfolios either by R&D, by strategic acquisitions of other patents, or by taking over other companies. In any of these cases, for smaller companies the distribution of committee chairs at the SSOs plays a crucial role. If company engineers will be able to go to the standard-setting meetings, their technology is more likely to succeed (Kang and Motohashi 2015). If now the home country of a smaller firm actively positions herself at the SSOs as was the case with South Korea and China, this supports both small and large domestic businesses. In a study concerning regular patents, Serrano (2010) shows that in the ICT sector 23.9% of the small innovators but only 7.9% of the large innovators trade their patents. If we assume these numbers to be similar for SEPs, we can conclude that larger SEP holders rather keep their SEPs to themselves and use them, smaller SEP holders might however be inclined to sell their IPR, possibly because they are too small to survive as IPR holders in their GVCs. To examine if only large SEP holders participate in standard-setting meetings or if there are also smaller firms present and to look into the trade patterns of SEPs in a comparable way to the aforementioned study will therefore be a feasible way to find out if SEPs in standards do hamper innovation in small companies due to a closed door policy or if there are equal opportunities for all market actors.

3.2 The role of the institutional environment

The closer examination of the effects of SEPs on trade also raises the question whether the international system of standardization with its main institutions like IEC and ISO is fit for the challenges of the 21st century. Standards set trajectories and lock in technologies for the years to come. While this can have a distorting effect on trade already, the issue of SEPs on the gains from trade debate highlights the need to investigate the effects that institutionalized international standardization might or might not have on the distribution of the gains from trade.

Figure 1 exemplifies, how much the constellation in international standardization is changing: China went from chairing just nine ISO-committees in 2004 to 60 in 2014, an almost sevenfold increase within ten years. South Korea more than doubled the number of committees that it chaired also starting from nine in 2004 to 19 in 2014.

Figure 1 Number of secretariats of ISO (sub-) committees held by the respective country.



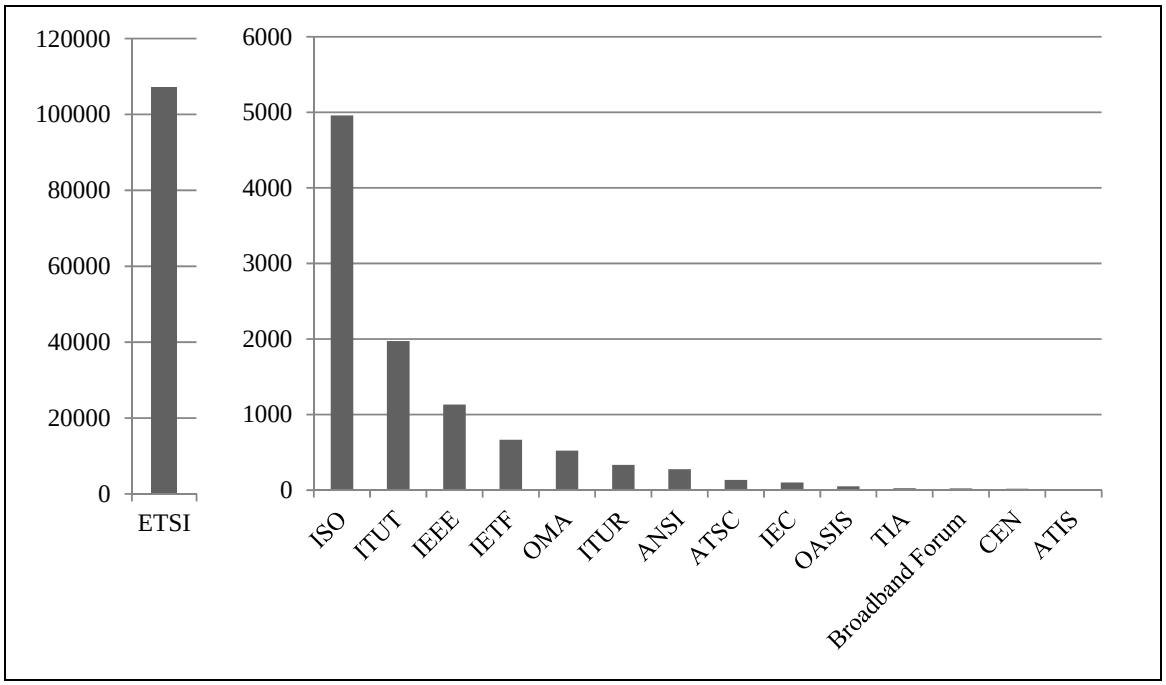
Source: Own illustration on the basis of data provided by Expertenkommission Forschung und Innovation (2015)

While this data shows the involvement of the countries in standard setting, it might be even more insightful to examine at which SSOs SEP holders disclose their SEPs. As we see from the data presented in Figure 2, by far the most SEPs are disclosed at the European Telecommunications Standards Institute (ETSI). The other standard setting bodies are a mix of formal SSOs such as ISO, ITU, IEEE, etc. and of a number of standards consortia. Such consortia are private business initiatives or platforms that bring together companies to set standards but that are less bureaucratic than formal SSOs. Especially in the fast-moving ICT business, standards consortia are an important coordination mechanism for SEP holders (Baron et al. 2014; Pohlmann 2014). Regarding the data it is especially noteworthy that with

the exception of ETSI, CEN, and the international SSOs, all of the remaining SSOs and consortia are US-based. There are two possible reasons for this.

One the one hand, SEP holders might go forum shopping for the best platform for disclosure of their SEPs (Lerner and Tirole 2006): SSOs and consortia offer different terms for SEP disclosure with regard to requirements, remuneration, level of bureaucracy, and with regard to the success of the standard on the market, and SEP holders are able to freely pick the organization they prefer on the market. The European, US-based and international institutions seem to offer the best solutions for SEP holders. Having forum shopping in mind, it might therefore be worthwhile for institutions in other countries to think about the quality of their standard setting and how it fits the needs of SEP holders. Drawing SEP holders into institutions in other countries might also have the benefit of technology inflows that might in turn strengthen the local economies.

Figure 2 Number of SEP disclosures per SSO (total, 2015 data).



Source: IPlytics GmbH (2015)

The second possible explanation for the US-focus of SEP holders is that the greatest part of the SEP-related innovation takes place at US-based companies. In this case, these firms would choose the SSOs and consortia in the same country to disclose their SEPs and consequently set the global standards. For other countries this would mean that the fostering of SEP-related innovation would have to go hand in hand with the building of strong standard setting bodies in the same country so that the innovations will not flow out. Possibly the US-concentration is also a result of the IPR regime that is prevalent in the United States. The IPR protection in the United States is known to be fairly strong; moreover it is possible to file patents for software which is neither the case in Europe nor in many other parts of the world. A legal environment

like this will of course attract companies that try to market their IPR in the most economically efficient and safe way. The disclosure of IPR is already a bold step for a company (especially when its whole business model relies on IPR) so that they will be likely to choose institutions in a relatively safe environment.

4 Conclusion

Using a macroeconomic study of trade flows, we are able to uncover the role of SEPs in GVCs of the ICT sector. SEPs prove to enhance trade between countries that are engaged in the ICT-related GVCs due to cross-licensing agreements that benefit both trading partners. As these companies that hold SEPs are a relatively small and closed-off club, SEPs, however, also raise antitrust issues and might hamper innovations in countries that are not already part of these production patterns. E.g., very recently the European Commission informed one of these firms about ongoing investigations regarding suspected abuse of market power by the means of exclusivity payments and predatory pricing (European Commission 2015a).

The examples of China and South Korea show that a country can have success that is induced by SEPs under very certain conditions. China, on the one hand, is able to profit from her large local market so that products that rely on a strictly national standardization system can be economically successful. South Korea, on the other hand, relied on technology inflows and on subsequent learning to be able to be innovative by herself.

Despite the success of these two Asian countries, looking deeper into the data of SEP disclosures we find a concentration in Europe and the United States. Assuming forum shopping of the involved companies, we propose that standard setting bodies need to be laid out attractively with regard to their procedures and also to the local IPR regime in order to become hubs for successful ICT standards.

Generally, we find that the macroeconomic effects of SEPs raise a number of questions that offer interesting paths for future research. We regard it as especially promising to engage in data-driven research on the microeconomic and firm level in order to test some of the propositions we stated in this think piece. As mentioned, most of the standardization bodies as well as consortia are US-based. One characteristic of the US standardization system is the de-centralized structure, i.e. there are numerous SSOs for different purposes (as opposed to the centralized European system with single national and European institutions). Collecting the SEP disclosure data is therefore difficult as it has to be obtained from each of the hundreds of institutions. For this reason, we rely on databases that provide this information. One possible source is the database maintained by IPLytics GmbH, who provide the data for commercial purposes but also engage in a research cooperation with TU Berlin. SEP data are generally available for very recent periods.

Regarding trade in value-added data, there are two main sources, one being the OECD-WTO TiVA Database (oe.cd/tiva) we used in the underlying study of this paper. The other source frequently used by trade economists is the World Input-Output Database (www.wiod.org). Trade data is usually released with a lag of some years, the latest versions of both databases accordingly cover the period 1995-2011. The second challenge with regard to trade data is the availability of sector-specific data. As we only consider the ICT sector, we first need to define the appropriate industry classes and then check this availability of disaggregated data for these sectors. The OECD-WTO TiVA Database, e.g., offers data for the sectors “Computer,

electronic and optical products" and "Computer and related activities" that probably best approximate the ICT sector although one might consider to also include "Post and telecommunications". The World Input-Output Database provides a similar arrangement.

In order to give some structured ideas for future research, we lastly propose several research approaches. The six companies mentioned in Table 1 have their headquarters in the United States (InterDigital, Qualcomm, Motorola), South Korea (LG Electronics), Finland (Nokia), and Sweden (Ericsson). In an effort to reveal the actual GVC structures, we propose to locate the headquarters of as many companies as possible that have disclosed SEPs. In a second step, following procedures like those of e.g. Timmer et al. (2014) or Marel (2015), one would disaggregate the GVC data to identify the actual streams of production in the SEP-related industries. A comparison of the two datasets could provide insights as to where the innovation that leads to SEPs happens versus where the production takes place. Moreover, the GVC data will be able to reveal where the gains from the value-added remain: Are they mainly attributed to the headquarters or does a part of them stay in (or return to) the countries that do the manufacturing?

Moreover, governmental policy actions could be an interesting strand of research. After the identification of countries that are successful actors in GVCs, be it as manufacturers or as GVC leaders, an analysis of the policy actions that resulted in the success could yield interesting findings.

In case comprehensive firm level data is available, one could be able to follow the flows of SEPs. Interesting questions would be who the actual innovators are and how they market their SEPs or potential SEPs. Do small innovators have chances in standard setting to have their inventions included in a standard? Or do they rather sell promising patents to one of the big players and only these have the power in standard setting to make their patents standard-essential? This path of research will allow us to understand the process of cross-licensing in detail. The requirement for very reliable, disaggregated, and sometimes secret data is, however, difficult to meet.

5 Publication bibliography

Anderson, James E. (1979): A Theoretical Foundation for the Gravity Equation. In *American Economic Review* 69 (1), pp. 106–116.

Anderson, James E.; van Wincoop, Eric (2003): Gravity with Gravitas: A Solution to the Border Puzzle. In *American Economic Review* 93 (1), pp. 170–192.

Anderton, Bob (1999): Innovation, Product Quality, Variety, and Trade Performance: An Empirical Analysis of Germany and the UK. In *Oxford Economic Papers* 51, pp. 152–167.

Baldwin, Richard (2013): Global Supply Chains: Why They Emerged, Why They Matter, and Where They Are Going. In Deborah Kay Elms, Patrick Low (Eds.): Global Value Chains in a Changing World.

Baron, Justus; Ménière, Yann; Pohlmann, Tim (2014): Standards, consortia, and innovation. In *International Journal of Industrial Organization* 36, pp. 22–35.

Bekkers, R.; Birkman, L.; Canoy, M.; Bas, P. de; Lemstra, W.; Ménière, Y. et al. (2014): Patents And Standards: A Modern Framework For IPR Based Standardisation. European Commission; ECSIP Consortium. Rotterdam, Netherlands.

Bekkers, R.; Bongard, René; Nuvolari, Alessandro (2011): An empirical study on the determinants of essential patent claims in compatibility standards. In *Research Policy* 40 (7), pp. 1001–1015.

Bekkers, Rudi; Martinelli, Arianna (2012): Knowledge Positions in High-Tech Markets: Trajectories, Standards, Strategies and True Innovators. In *Technological Forecasting & Social Change* 79 (7), pp. 1192–1216.

Berg, Sanford V. (1989): Tehnical Standards as Public Goods: Demand Incentives for Cooperative Behaviour. In *Public Finance Review* 17 (1), pp. 29–54.

Bessen, James; Maskin, Eric (2009): Sequential innovation, patents, and imitation. In *The RAND Journal of Economics* 40 (4), pp. 611–635.

Blind, Knut (2004): The Economics of Standards. Theory, Evidence, Policy. Cheltenham, UK, Northhampton, MA, USA: Edward Elgar.

Blind, Knut; Bekkers, Rudi; Dietrich, Yann; Iversen, Eric; Köhler, Florian; Müller, Benoît et al. (2011): Study on the Interplay between Standards and Intellectual Property Rights (IPRs). European Commission. Luxemburg.

Blind, Knut; Cremers, Katrin; Mueller, Elisabeth (2009): The influence of strategic patenting on companies' patent portfolios. In *Research Policy* 38 (2), pp. 428–436.

Blind, Knut; Edler, Jakob; Frietsch, Rainer; Schmoch, Ulrich (2006): Motives to Patent: Empirical Evidence from Germany. In *Research Policy* 35 (5), pp. 655–672.

Blind, Knut; Jungmittag, Andre (2005): Trade and the Impact of Innovations and Standards: the Case of Germany and the UK. In *Applied Economics* 37 (12), pp. 1385–1398.

Choi, Thomas Y.; Budny, Jaroslaw; Wank, Norbert (2004): Intellectual property management: A knowledge supply chain perspective. In *Business Horizons* 47 (1), pp. 37–44.

Deardorff, Alan (1998): Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World? In Jeffrey A. Frankel (Ed.): The regionalization of the world economy. Chicago: University of Chicago Press.

Dedrick, Jason; Kraemer, Kenneth L.; Linden, Greg (2010): Who profits from innovation in global value chains?: a study of the iPod and notebook PCs. In *Industrial and Corporate Change* 19 (1), pp. 81–116.

Ernst, Dieter (2011a): Indigenous Innovation and Globalization - The Challenge for China's Standardization Strategy. Institute on Global Conflict and Cooperation; East-West Center.

Ernst, Dieter (2011b): Toward Greater Pragmatism? China's Approach to Innovation and Standardization. Institute on Global Conflict and Cooperation (SITC Research Briefs, Policy Brief No. 18).

European Commission (2014): Competition Policy Brief. Standard-Essential Patents (Issue 8).

European Commission (2015a): Antitrust: Commission Sends two Statements of Objections on Exclusivity Payments and Predatory Pricing to Qualcomm. Available online at http://europa.eu/rapid/press-release_IP-15-6271_en.htm (IP/15/6271), checked on 12/15/2015.

European Commission (2015b): Report on Competition Policy 2014. Brussels (COM(2015) 247 final).

Expertenkommission Forschung und Innovation (2015): EFI Report 2015. Gutachten zu Forschung, Innovation und technologischer Leistungsfähigkeit Deutschlands.

Farrell, Joseph; Hayes, John; Shapiro, Carl; Sullivan, Theresa (2007): Standard Setting, Patents and Hold-Up. In *Antitrust Law Journal* 74 (3), pp. 603–670.

Garcia, Linda; St. Clair, Karolyn (1992): Global Standards: Building Blocks for theFuture. With assistance of Sherry Emery, John Alic, Sebastian Remoy, Alan Davidson. U.S. Congress, Office of Technology Assessment. Washington, DC.

Gereffi, Gary; Humphrey, John; Sturgeon, Timothy (2005): The Governance of Global Value Chains. In *Review of International Political Economy* 12 (1), pp. 78–104.

Gereffi, Gary; Sturgeon, Timothy (2013): Global Value Chain-Oriented Industrial Policy: The Role of Emerging Economies. In Deborah Kay Elms, Patrick Low (Eds.): Global Value Chains in a Changing World.

Graevenitz, Georg von; Wagner, Stefan; Harhoff, Dietmar (2011): How to measure patent thickets—A novel approach. In *Economics Letters* 111 (1), pp. 6–9.

Graevenitz, Georg von; Wagner, Stefan; Harhoff, Dietmar (2013): Incidence and Growth of Patent Thickets: The Impact of Technological Opportunities and Complexity. In *Journal of Industrial Economics* 61 (3), pp. 521–563.

Greenalgh, Christine; Taylor, Paul; Wilson, Rob (1994): Innovation and Export Volumes and Prices - A Disaggregated Study. In *Oxford Economic Papers* 46, pp. 102–134.

Grindley, Peter C.; Teece, David J. (1997): Managing Intellectual Capital: Licensing and Cross-Licensing in Semiconductors and Electronics. In *California Management Review* 39 (2), pp. 1–34.

IPlytics GmbH (2015): Data Analysis on Standard Essential Patent (SEP) Declarations. Available online at http://www.iplytics.com/download/docs/studies/IPlytics%20SEP%20Analysis.pdf, checked on 12/14/2015.

Kang, Byeongwoo; Huo, Dong; Motohashi, Kazuyuki (2014): Comparison of Chinese and Korean Companies in ICT Global Standardization: Essential Patent Analysis. In *Telecommunications Policy* 38 (10), pp. 902–913.

Kang, Byeongwoo; Motohashi, Kazuyuki (2015): Essential intellectual property rights and inventors' involvement in standardization. In *Research Policy* 44 (2), pp. 483–492.

Kaplinsky, Raphael (2010): The Role of Standards in Global Value Chains. World Bank (Policy Research Working Paper, 5396).

Kim, Linsu (1997): Imitation to Innovation: The Dynamics of Korea's Technological Learning: Harvard Business Press.

Lerner, Josh; Tirole, Jean (2004): Efficient Patent Pools. In *American Economic Review* 94 (3), pp. 691–711.

Lerner, Josh; Tirole, Jean (2006): A Model of Forum Shopping. In *American Economic Review* 96 (4), pp. 1091–1113.

Lerner, Josh; Tirole, Jean (2015): Standard-Essential Patents. In *Journal of Political Economy* 123 (3), pp. 547–586.

Marel, Erik van der (2015): Positioning on the Global Value Chain Map: Where do You Want to Be? ECIPE (ECIPE Occasional Paper, No. 01/2015).

Miroudot, Sébastien; Nordström, Håkan (2015): Made in the World? European University Institute (EUI Working Paper, RSCAS 2015/60).

Nadvi, K. (2008): Global Standards, Global Governance and the Organization of Global Value Chains. In *Journal of Economic Geography* 8 (3), pp. 323–343.

Nagaoka, Sadao; Kwon, Hyeog Ug (2006): The incidence of cross-licensing: A theory and new evidence on the firm and contract level determinants. In *Research Policy* 35, pp. 1347–1361.

OECD (2013): OECD Science, Technology and Industry Scoreboard 2013. Innovation for Growth.

Pohlmann, Tim (2014): The Evolution of ICT Standards Consortia. In *Communications & Strategies* 95 (3), pp. 17–40.

Pohlmann, Tim; Neuhäusler, Peter; Blind, Knut (2015): Standard Essential Patents to Boost Financial Returns. In *R&D Management*.

Ramel, Florian; Blind, Knut (2015): The Influence of Standard Essential Patents on Trade. In Katrine Bergh Skriver, Kai Jakobs, Jesper Jerlang (Eds.): EURAS Proceedings 2015. The Role of Standards in Transatlantic Trade and Regulation. Aachen: Mainz, pp. 359–376.

Serrano, Carlos J. (2010): The Dynamics of the Transfer and Renewal of Patents. In *RAND Journal of Economics* 41 (4), pp. 686–708.

Shapiro, Carl (2001): Navigating the patent thicket: Cross licenses, patent pools, and standard setting. In Adam B. Jaffe, Josh Lerner, Scott Stern (Eds.): Innovation Policy and the Economy. Volume 1. Cambridge, MA: MIT Press, pp. 119–150.

Timmer, Marcel P.; Erumban, Abdul Azeez; Los, Bart; Stehrer, Robert; Vries, Gaaitzen J. de (2014): Slicing Up Global Value Chains. In *Journal of Economic Perspectives* 28 (2), pp. 99–118.

Tinbergen, Jan (1962): Shaping the World Economy - Suggestions for an International Economic Policy. New York: The Twentieth Century Fund.

U.S. Department of Justice and U.S. Patent & Trademark Office (2013): Policy Statement on Remedies for Standard-Essential Patents Subject to Voluntary F/RAND Commitments.

Available online at http://www.uspto.gov/about/offices/ogc/Final_DOJ-PTO_Policy_Statement_on_FRAND_SEPs_1-8-13.pdf, checked on 12/14/2015.

WIPO (2011): World Intellectual Property Report. The Changing Face of Innovation. Geneva, Switzerland (WIPO Economics and Statistics Series).