

# **Standardization and Standards as Research and Innovation Indicators: Current opportunities and future challenges**

**Knut Blind<sup>a,b</sup>**

<sup>a</sup> Technische Universität Berlin, Chair of Innovation Economics,  
Marchstraße 23, 10587 Berlin, Germany

<sup>b</sup> Fraunhofer Institute of Open Communication Systems FOKUS,  
Kaiserin-Augusta-Allee 31 10589 Berlin, Germany

## **Abstract**

The focus of innovation policies has been shifted from knowledge creation, e.g. by patent protection, to knowledge diffusion, e.g. via open access, in order to promote its implementation. Consequently, innovation indicators are increasingly needed, which reflect the implementation of knowledge within innovative products and services. Standardization as a kind of open innovation process and standards as its output represent a new type of innovation indicator. Whereas in a first section the existing opportunities of using standards and standardization as innovation indicators are presented, the following section identifies the future challenges to close the – in comparison to patent data – still very significant data gaps. The paper concludes with examples how policy makers could make use of a comprehensive database of standardization and standards to evaluate innovation policy initiatives.

## 1. Introduction

In the 1990s the increasing relevance of intellectual property rights (IPR), especially patents and the parallel accessibility of patent data, like via PATSTAT, provided by the European Patent Office and OECD, led to a virtuous cycle accompanied by broadening the investigation areas and improving the data quality. However, despite the increasing relevance of IPR, the number of patent applications, especially in Western countries, has been stagnating or even decreasing (WIPO 2015). The importance of accessing, diffusing and implementing knowledge, in contrast to knowledge creation and protection has, however, received recently more attention from policy makers, e.g. the shift in focus in the current European framework programme Horizon 2020 from research to innovation or fostering open access in science or open innovation (Moedas 2015, European Commission 2016).

The measurement of the implementation of innovative ideas has already been addressed by researchers focusing on patents, but the question whether patents are actually used can only be answered by inventors' surveys, e.g. recently by Torrisi et al. (2016) and Ploschka (2016), or by specific case studies, e.g. focusing on complex products like laptops (Biddle et al. 2010). Certainly, analyzing innovative ideas actually implemented in new products is certainly the more accurate, but also very cumbersome approach. Consequently, the analysis of the development and the implementation of standards is an alternative and complementary approach, because the additional effort to develop common standards is a strong indication that the innovative ideas are eventually implemented in products and processes and not only used for strategic reasons, e.g. like using patents to block competitors (Blind et al. 2006, Torrisi et al. 2016). Furthermore, standards cover product and even more process characteristics, which is less the case for patents (Cohen et al. 2000). Finally, standards address not only innovative technological aspects, but more and more services (Blind 2006a, Wakke et al. 2015) and recently also issues, like environmental management and corporate social responsibility. In contrast to patenting, which takes place within closed inventor teams, and in addition to open source activities, especially focused on software, standardization in publicly accredited national, European or international bodies and informal consortia, especially active in the information and communication technology (ICT), is generating also common knowledge, especially interesting for SMEs (Blind and Mangelsdorf 2016). In summary, standards and standardization represent opportunities for the generation of innovation indicators, which cover not only a much broader spectrum of innovation, but also

reflect a dynamic and open innovation process via the common development of standards, their revision and eventually substitution by the next generation of standards.

## **2. Current Opportunities**

Standards do not only contain knowledge, which is relevant for the production of products and services, but also for all interested stakeholders active in the research (Blind and Gauch 2009) and development (Grossmann et al. 2016) process. Examples are both terminology and measurement and testing standards, but also health, environmental quality and safety standards, which are necessary to create trust among early adopters of innovative new products and services, in addition to compatibility standards being the basis for the generation of positive network externalities (e.g. David and Greenstein 1990).

Standardization can also be linked to both scientific publications (Zi and Blind 2015) and patenting. Thus far, only standard essential patents characterized by a higher value measured via forward citations have received intensive empirical investigations which started with the seminal contribution by Rysman and Simcoe (2008) based on linking patent databases with information provided by the standards development organizations. The work in this field has developed further to analyze the motivations and strategies to include patents in standards (Baron et al. 2016; Bekkers et al, 2011, Berger et al. 2012; Kang and Motohashi 2015; Kang and Bekkers 2015) and their impact on company performance (Hussinger and Schwiebacher 2015; Pohlmann et al. 2015).

In parallel, company participation in standardization bodies (Blind 2006b; Blind and Mangelsdorf 2013; Wakke et al. 2015) and consortia (Leiponen 2008) has been researched in-depth either based on surveys or membership information and confirm the general positive relationship between innovation activities and successes on the one hand and standardization on the other hand. Individual researchers' involvement in standardization is a rather unexplored topic, because the mostly confidential information can only be accessed via internal databases (Zi and Blind 2015) or surveys (Ploschka 2016). Here, the relationship to researchers' performance measured by scientific publications or patent applications provides ambivalent results.

On the macroeconomic level, the impact of standards as indicators for countries' or industries' innovativeness measured as stocks of standards provided by a commercial data basis operated by standard developing organizations on economic growth (e.g. Blind and

Jungmittag 2008) or on trade (Swann 2010), has – like patents – proven to be generally positive. Whereas the number of existing standards (e.g. Baron and Spulber 2015) is a rather blunt measure, the International Standardization Organization (ISO) provides data about the implementation of the most important management standards, such as the more than one million certifications of ISO 9001 (Guler et al. 2002), the quality management system, and the environmental management system of ISO 14001. However, whereas the relationship between the ISO 9001 certification and innovation is ambivalent on the company level (Manders et al. 2016), the link between ISO 14001 and innovation is positive at least at country level (Lim and Prakash 2014).

Unfortunately, systematic data about the implementation of other standards is not available. A first study focused on the number of standards implemented e.g. in the production of a laptop (Biddle et al. 2010). Recently, Ploschka (2015) identifies the implementation of standards within the whole product portfolio of a company producing in hydraulic products. Although this approach requires significant efforts, this study confirms at least the feasibility of such an approach.

However, the options for data collection have since been expanded within country-wide company surveys. For example, previous British editions of the Community Innovation Survey included questions about the role of standards as innovation sources and barriers (Swann 2005, Frenz and Lambert 2013) and German editions of the Community Innovation Survey integrated in addition explicitly distinguishing between standards and regulations as barriers to innovation on a regular basis which allows longitudinal analyses (Rammer et al. 2016a). Recently, German companies have been asked about their active involvement in standardization (Rammer et al. 2016b). In addition, data provided by national standardization offices are matched to the Community Innovation Survey, e.g. in the Netherlands (Wakke et al. 2015) or Germany (Blind and Pohlisch 2016). All these studies show positive correlations between innovation activities and success and the role of standards as information sources or the participation in standardization.

Starting with a pilot survey in 2012, Germany launched the German Standardization Panel addressing the 10.000 companies active in the national standardization body DIN e.V.. The panel has meanwhile been surveyed four times and is based on more than 1.000 companies which are more than 10% of the universe of standardizing companies. Currently, efforts have been started to involve the more than 100.000 German companies buying standards assuming

that they implement standards without being actively involved in standardization (Blind and Müller 2016). Starting with the fifth wave of the panel starting in October 2016, the German Ministry of Economic Affairs and Energy (BMWi) will take over the patronage for the envisaged long-term initiative. Finally, research and other institutions like test laboratories are an additional target group to be surveyed in order to complement the company perspective.

### **3. Future Challenges**

Critically evaluating the existing opportunities of using standardization activities and published standards as research and innovation indicators, we observe a significant fragmentation in various dimensions.

In contrast to the basic Community Innovation Survey obligatory for all Member States of the European Union, standardization has only been included in the national editions in the United Kingdom and Germany. In addition, even the questionnaires versions of these two countries are not aligned and the consistency over time, i.e. between different waves, within the British survey has not been achieved. Specific approaches to set up panels fully dedicated to standardization can only be observed for Germany so far. Attempts to leverage this national focused initiative cannot yet be observed.

In parallel, whereas PATSTAT provides patent data in a standardized format for all major patent offices, a similar database is not available for standards. The quality of the data for a few European countries is of a rather high level, which is not the case for the majority of European countries. Furthermore, the rather decentralized standardization system in the United States with several hundred standardization bodies represents a fragmented landscape itself.

Addressing these two dimensions of fragmentation would require on the one hand the inclusion of the topic of standardization in the basic module of the Community Innovation Survey obligatory for all Member States and at least within a regular cycle of four or even two years. An alternative would be the establishment of an international standardization survey, because we observe a shift of standardization activities not only from the national to the European, but to the international level also driven by the numerous consortia being active at the international level. On the other hand the fragmentation and heterogeneity in quality related to standards databases would require a joint international initiative similar to the achievements reached by PATSTAT.

In addition two further challenges, which have also not yet been successfully tackled by the Community Innovation Survey and the patent databases, have to be mentioned. As we know from the vast amount of previous research, a close interaction between the various stakeholders and institutions is needed to realize a well-functioning innovation system. However, the Community Innovation Survey is focused on companies and their perspectives. Therefore, this narrow focus needs a widening to include both research institutes and other institutions on the one hand and the consumer on the other hand. This extension would also be beneficial for a standardization survey, because of the important contributions of research institutes for the development of standards and the high relevance of users for their implementation.

As already mentioned, the existing patent databases provide only information about the application details and the current legal status of a patent, but not about its actual implementation in products and services. Although we can assume, that stakeholders invest only resources in a standardization process, when they are interested in implementing the standard, because there are little strategic motives, like blocking competitors via standards, we face a similar challenge related to standards. Since, the existing standard databases do in general not provide information about their implementation with the exception of the few very visible management standards, like ISO 9001 on quality management or ISO 14001 on environmental management. However, this type of information would valuable insights about the diffusion of standards.

Overall, the availability of data about standardization activities or standards and their impacts on innovation and companies' commercial success has to catch up to already available data on innovation activities, successes and their impacts in general and patents in particular. In addition, going one step further requires the inclusion of other actors of the innovation system in such survey approaches, but also addressing the implementation of standards to capture better their diffusion over time, countries and industries.

#### **4. Relevance for Policy Makers**

These new opportunities to collect data about standards and their implementation could be used by policy makers to evaluate already running research and innovation programmes and design upcoming programmes, but also a country's innovation policy in general.

One past example would have been the Lead Market Initiative of the European Commission (European Commission 2007), which focused primarily on the three instruments of public procurement, legislation and standardization (Edler et al. 2012). The final evaluation of the LMI (CESS/Oxford Research 2011) could have been based on rigorous quantitative analyses using time series data even allowing the application of the difference in differences approach. The since 2014 running European research and innovation programme Horizon 2020 has also included standardization processes and standards as additional success indicators for innovation in addition to scientific publications and patents (European Commission 2011a, 2011b, 2011c). Here again, control groups of companies being not promoted by the programme and previously not involved in standardization could be generated based on an Community Innovation Survey including sections on companies' involvement in standardization and implementation of standards.

For benchmarking the German innovation system in general, the Commission of Experts for Research and Innovation (2015), which advises the German Federal Government, has included the number of secretaries within ISO by country as performance indicator besides scientific publications and patents in their annual report on research, innovation and technological performance in Germany (EFI 2015). Besides the dominant position of the United States and Germany, China is rapidly catching up, but also Brazil as emerging country is expanding its international standardization activities. Future innovation policy initiatives might consider subsidizing companies' active in international standardization committees to represent national interests not only in a commercial sense, but also in ethical debates related to genetically modified organisms or privacy issues, e.g. data protection in the cloud (Löhe and Blind 2015).

Furthermore, standards are an element of the national regulatory framework (e.g. European Commission 2016) and consequently technical barriers to trade (TBT) in international trade in case of heterogeneous national solutions, e.g. a crucial challenge to the negotiations about the Transatlantic Trade and Investment Partnership TTIP (Egan and Pelkmans 2015). Since institutions are important elements of national innovation systems, institutional changes have implications for the level and directions of innovation. Consequently, the availability of data about the impact of standards on innovation could provide a sound database for the ex ante assessment of the institutional changes of the standardization system in European Union and its Member States on the future development of its innovation system (see Blind 2016 on the current insights about the impact of standardization and standards on innovation).

In summary, the policy relevance of standardization for innovation is progressing from the OECD members to the global level including especially the large and fast growing emerging countries. However, the potential of standardization as an effective and efficient instrument to promote innovation has not yet fully perceived and exploited by policy makers. For example, in the new publication of the European Commission (2016) on open innovation, open science and the openness to the world, international collaboration in science and research is not only perceived as fostering open innovation yielding positive impacts in terms of scientific quality and research results, but also global standard-setting is recognized to be able to tackle global challenges to more effectively and facilitating participation in global value chains and new and emerging markets. However, the potential of standardization is not yet fully perceived and implemented in the presented strategies to promote open innovation, e.g. by not explicitly considering standards in reforming the regulatory environment, or to push open science, e. g. by particularly accepting standards as another output of research and innovation activities besides publications and patents although already addressed in Horizon 2020 (European Commission 2011c).



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