International Centre for Innovation

Solvay Brussels School
Economics & Management

LANGUAGES, FEES AND THE INTERNATIONAL SCOPE OF PATENTING

Author

Dietmar Harhoff [ab], Karin Hoisl[ae], Bruno van Pottelsberghe de la Potterie [bcd], Charlotte Vandeput[c]

[a] *Max Planck Institute for Innovation and Competition, Munich and University of Munich (LMU)*
[b] *Centre for Economic Policy Research (CEPR), London, UK*
[c] *Université libre de Bruxelles, SBS-EM, ICITE, avenue F.D. Roosevelt 50 CP 146 ,1050 Brussels, Belgium*
[d] *Bruegel, Brussels*
[e] *Copenhagen Business School, Copenhagen, DK*

iCite Working Paper 2015 - 11

iCite - International Centre for Innovation, Technology and Education Studies
Université Libre de Bruxelles – CP 146
50, avenue F.D. Roosevelt – B-1050 Bruxelles – Belgium
www.solvay.edu/iCite

Languages, Fees and the International Scope of Patenting

Dietmar Harhoff [ab], Karin Hoisl[ae], Bruno van Pottelsberghe de la Potterie [bcd], Charlotte Vandeput[c]

[a] *Max Planck Institute for Innovation and Competition, Munich and University of Munich (LMU)*

[b] *Centre for Economic Policy Research (CEPR), London, UK*

[c] *Université libre de Bruxelles, SBS-EM, ICITE, avenue F.D. Roosevelt 50 CP 146 ,1050 Brussels, Belgium*

[d] *Bruegel, Brussels*

[e] *Copenhagen Business School, Copenhagen, DK*

Abstract

This paper analyzes firms' choices regarding the geographic scope of patent protection within the European patent system. We develop an econometric model at the patent level to quantify the impact of office fees and translation costs on firms' decision to validate a patent in a particular country once it has been granted by the European Patent Office. These costs have been disregarded in previous studies. The results suggest that both translation costs and fees for validation and renewals have a strong influence on the behavior of applicants.

JEL Classification: O30, O31, O38, O57

Keywords: patents, patent fees, patent validation, renewal fees, translation costs

Acknowledgments

The authors thank Nicolas van Zeebroeck for developing the methodology for identifying validations and for constructing the dataset. The authors would like to thank the EPO for providing access to the patent renewal data used in this paper and Bettina Reichl for extracting the fee data. Dietmar Harhoff acknowledges support by the Deutsche Forschungsgemeinschaft (DFG) within its SFB/TR 15 collaborative research programme (Project C2). Furthermore, the authors would like to thank Georg von Graevenitz, seminar audiences at KU Leuven, ZEW Mannheim, in particular, Alberto Galasso, and the 3rd EPIP Conference for helpful comments.

1. Introduction

Recent developments in patenting activity are the subject of a growing literature. Existing work contributes to a better understanding of the incentives that drive economic agents to rely on the patent system (e.g., Cohen et al., 2000; Arundel, 2001; Peeters and van Pottelsberghe, 2006; Blind et al., 2006; von Graevenitz et al., 2013), and on potential implications of their behavior for the effectiveness of the patent system. Lately, a number of researchers have started to explore the design of the patent system itself, i.e. the role of fees and costs of patenting (Archontopoulos et al., 2007; Harhoff et al., 2009; de Rassenfosse and van Pottelsberghe, 2013), the duration of examination (Thomas, 2010; Harhoff, 2011), as well as patent office governance and management (Friebel et al., 2006).

Recent changes in the European patent system comprise the coming into force of the London Agreement in 2008[1], the agreement of the EU Council to draft EU regulations regarding an EU Patent in 2011[2], and the introduction of new claim-based[3] fees at the European Patent Office (EPO) in 2008 and 2009[4]. Whereas the first two changes aimed at reducing the burden of costs for the applicants of European patents (EP), the latter change aimed at increasing patenting costs to reduce the complexity of applications. Even though many practitioners have argued that patent office fees account for only a small fraction of total patenting costs, they often represent marginal costs while attorney fees – which are assumed to make up for the major part of patenting costs – are largely sunk *ex-ante*. First empirical evidence points to a considerable impact of fees. Archontopoulos et al. (2007), for instance, find that after an increase of the claim fee in the US in 2004[5], the average number of claims per patent decreased from 28 to 23. De Rassenfosse and van Pottelsberghe (2012) summarize evidence from empirical studies indicating inelastic, though not small, reactions to fee changes ranging between -0.03 and -0.60.

With the exception of early work by Pakes (1986) and Schankerman and Pakes (1986) and empirical analyses by Lanjouw (1998) who analyze the impact of post-grant renewal fees and litigation costs, existing research has focused on pre-grant fees and costs. The objective of this paper is to provide an in-depth analysis of the impact of post-grant costs and fees, i.e.,

[1] See http://www.epo.org/law-practice/legal-texts/london-agreement.html (accessed on Jan. 27, 2012).
[2] See http://www.epo.org/law-practice/legislative-initiatives/eu-patent.html (accessed on Jan. 27, 2012).
[3] Claims define the legal scope of a patent, they are used to describe the technological scope of a protection
[4] See http://www.epo.org/service-support/updates/2008/20080305f/claims-fees.html (accessed on Jan. 27, 2012).
[5] Up to 2004, the USPTO changed $ 18 for 21st and each subsequent claim. From December 2004, it increased the claims fee to $ 50 for 21st and each subsequent claim (Archontopoulos et al. 2007).

translation costs and fees for validating an EP patent in different jurisdictions as well as for keeping it in force. The European patent system provides an excellent setting for understanding the drivers of international patenting strategies, since it imposes rather heterogeneous cost regimes on patent applicants. Once a patent is granted by the EPO, the applicant has the option, but not the obligation to validate the patent in any of the countries for which patent protection was requested. At this point, the patent may have to be translated into a different language. Hence, these costs are marginal in the sense that at the point of decision-making all examination and application fees are sunk, the grant decision has been made, and the receipt of the national patent only depends on the costs considered here.

Translations into Nordic languages or Greek are, for instance, particularly expensive. First, because these languages are rare, i.e. the number of native speakers is small. Second, for Greek, since the distance between this language and English, German or French is particularly large, this increases the translations costs. Hence, linguistic distances may affect patenting decisions. More specifically, patents may not be validated in some countries due to high costs associated with a translation.

We provide estimates of the impact of post-grant fees and costs on patenting using a model of validation decisions as a function of translation costs and fees for validating and maintaining the patent. In the following, an empirical model of validation behavior is tested with a unique dataset comprised of all patents that were granted by the EPO in 2003.[6] Given our research design, our estimates are also informative about the determinants of the geographical scope of patenting. While the extension of international patent families is frequently used as an indicator of patent value (Putnam, 1996; Harhoff et al. 2003), its determinants have hardly been identified. Only a few studies have focused on the drivers of international patenting, e.g., Bosworth (1984), Eaton and Kortum (1996), Porter and Stern (2000), and Deng (2007). None of them have taken into account the role of translation costs. Our empirical results suggest that the size and the wealth of the origin and destination countries significantly affect the probability of observing a patent validation. These determinants reflect the benefits that a particular applicant from one country will enjoy from patenting in another European Patent Convention (EPC) country. The geographical distance between countries also plays an important role – costs of transportation are still present and limit the benefit of a patent, since the world is not "completely flat" (Friedman 2006). The costs of translating EPO-granted

[6] In another paper (Harhoff et al. 2009) we rely on a complementary approach, analyzing the validation behaviour at the aggregate level of country-to-country patent flows.

patents into different European languages and the level of validation and renewal fees affect the probability of patent validation negatively.

Our results provide potentially important policy implications. The patent system has originally been designed to provide incentives to create innovation. Lately, firms increasingly have learned to use it strategically to gain advantage over their competitors. Our results show that fee changes are potentially important elements of patent office policies seeking to impact applicant behavior – higher fees will have a dampening effect on patent validations. This is even more important given that changes or adaptations to administrative rules of patent systems typically require lengthy processes, which have to take into account the views of different stakeholders. Conversely, changes in the level of fees can be introduced quickly in order to curb or encourage particular developments.

The paper is structured as follows. In the next section, we discuss the institutional context of the European patent system and develop the hypotheses to be tested. Section 3 describes the dataset, the construction of the dependent and explanatory variables and the econometric framework. Descriptive statistics are discussed in section 4. The results of the multivariate tests are presented and interpreted in section 5. Section 6 concludes.

2. Institutional background and hypotheses

The EPO grants patents for each of the signatory or accession states to the EPC. The EPC signed in Munich in 1973 is a contract constituting the European Patent Organization and providing an independent legal system under which European patents are to be granted. The EPC came into force in 1977 and the EPO was founded in the very same year. On June 1, 1978, the first European patent application was filed with the EPO. Table 1 contains a list of today's 38 member states and the date of entry into the European system.

[Please insert Table 1 about here]

Applications may be filed directly at the EPO (as first filings) or be forwarded to the EPO within the priority year after having been filed as a priority application in a national patent office (NPO).[7] At the latest after one year (under the EPC[8]) or 31 months (under the Patent

[7] Cf. Guellec and van Pottelsberghe (2007) and Stevnsborg and van Pottelsberghe (2007) for an in-depth description of the various filing routes which may lead to an application at the EPO.

Cooperation Treaty[9] (PCT)), the application may be transferred to the EPO. Historically, the EPO examination process has taken slightly more than 4 years (Harhoff and Wagner, 2009 and van Zeebroeck, 2007).

The EPC states in which the applicant would like to receive patent protection have to be designated by the applicant. The designation is subject to the payment of a designation fee. The term for designating EPC member states expires six months after the European Patent Bulletin announces the publication of the search report (Article 79 (2) EPC). However, contracting states "may be withdrawn at any time up to the grant of the European patent" (Article 97 (3) EPC).[10] Before July 1999, applicants were obliged to pay a designation fee for *each* designated contracting state (Article 2 (2), (3) Rules relating to Fees). In December 1998, the EPO amended its "Rules relating to Fees". Effective as of July 1, 1999 "designation fees being deemed paid for all contracting states upon payment of seven times the amount of this fee" (amended Article 2 (3) Rules relating to Fees).[11] Thus, with the payment of designation fees for seven countries, it became possible to designate all EPC countries.

The choice of the regional scope of patent protection is made by the applicant once the patent has been granted. At that time, the applicant must eventually have the patent translated into the official languages of these countries, and pay the validation fees as well as the renewal fees for each year of protection.[12] The setup is, therefore, appropriate for assessing the sensitivity of applicants to marginal increases of fees and transactions costs.

In what follows, we take into account the extant analyses of firms' patenting behavior in order to derive hypotheses regarding the potential determinants of the geographical scope chosen by firms. One of the early studies on the geographical scope of patent protection is provided by Slama (1981). The author investigates the determinants of international patent application flows at the country level using German patent application data between 1967 and 1978. Bosworth (1984) uses UK patent data from 1974 to assess the factors influencing the decision to transfer technology across borders. The two studies suggest that the GDP of both the

8 See http://www.epo.org/about-us/organisation/member-states.html (accessed on September 8, 2011).

9 The Patent Cooperation Treaty was signed in Washington in 1970 and entered into force in 1978. By filing a patent application under the PCT, it is possible to obtain protection in up to 138 PCT contracting states (see http://www.wipo.int/pct/en/treaty/about.htm (accessed on September 8, 2011).

10 See http://www.epo.org/law-practice/legal-texts/epc.html, accessed on September 8, 2011.

11 See http://www.epo.org/law-practice/legal-texts/archive/documentation/rules-relating-fees.html, accessed September 8, 2011.

12 This fragmentation of the European patent system has been criticized for years by the business sector, as it induces a high managerial complexity and is associated with relatively high cumulative fees and translation costs. Cf. van Pottelsberghe and François (2009) and van Pottelsberghe and Mejer (2010) for simulations of total patenting costs in the European patent system. International comparisons show that even after the London Agreement the costs of patenting are at least four times higher in Europe than in the US.

applicant's and the target country are relevant for the validation decision. Once GDP is accounted for, Slama (1981) does not find any significant influence of the population of the destination and the source country on patent application flows between two countries.

So far, little research has been done on the influence of costs and fees on the patenting behavior of firms.[13] Pakes and Schankerman (1984) and Schankerman and Pakes (1986) have shown that renewal decisions are affected by the level of renewal fees. A few other studies have investigated the role of patent fees. For instance, de Rassenfosse and van Pottelsberghe (2013) show that priority filing fees at national patent offices have a negative and significant impact on the number of patent applications. However, the demand for first filings at national offices is determined by a rather complex set of factors. An alternative and potentially more telling experiment would be to analyze the patents already granted by one institution and then analyze in which countries they are then taken for validation. The present study pursues this approach and uses the validation phase following the EPO grant as the research setting.

The research design adopted in the present paper allows identifying the impact of post-grant fees and translation costs on the patenting behavior of applicants. Post-grant fees (i.e., translation costs, validation fees and fees for maintaining patent protection for the years 4 to 6 after application at the EPO) are of particular importance for our analysis, since we assume that they drive the validation decision of applicants and consequently are important determinants of the scope of protection. Moreover, these costs are marginal in the sense that at the point of decision-making all examination and application fees are sunk, and the receipt of the national patent only depends on the costs considered here. We also take early renewal fees into account because they represent the expenses that an applicant has to pay when extending patent protection once the patent has been validated. We use the renewal fees requested by the national patent offices from years 4 to 6 after the application date at the EPO as a measure of these costs.

Assuming that applicants rationally decide about the regional scope of their patent portfolio, the following hypotheses relating to translation costs as well as validation and early renewal fees are put forward:

[13] de Rassenfosse and van Pottelsberghe (2007) investigate the role of priority filing fees at national patent offices and Harhoff et al. (2009) analyse the extent to which fees explain validation flows at the country level using a gravity model. de Rassenfosse and van Pottelsberghe (2012) provide time series evidence on the potential impact of cumulated fees at the USPTO, JPO and EPO on the demand for patents. All these studies obtain results that suggest that fees influence the patenting behaviour of applicants.

H.1a: *The probability of patent validation in an EPC country decreases with an increase in relevant translation costs.*

H.1b: *The decreasing effect of translation costs on the probability of patent validation is stronger for more voluminous patents.*

H.2: *The probability of patent validation in an EPC country decreases with an increase in the country-specific validation fees.*

H.3: *The probability of a patent validation in an EPC country decreases with an increase in the country-specific early renewal fees.*

3. Data and econometric modeling

The paper uses a novel dataset on validation decisions of applicants at the EPO. The data comprise all patents granted by the EPO in 2003. Information on filing and grant dates, the country of origin of the priority filings, the language of the official proceedings at the EPO and the technical classification of the patent application (IPC classes) were extracted from the EPO's EPASYS database as of January 15, 2006. Data on the lapse of patents into the public domain was obtained from the EPASYS database as of December 2006. The data were supplemented with information on renewal payments, which were received from the EPO post grant system as of December 2006. The empirical analysis relies on 53,904 patents granted in 2003 and validated in at least one EPC member state. Granted patents, which had not been validated in any of the EPC member states were excluded from the dataset. [14]

3.1 The econometric model

The probability of observing a validation of a patent from applicant country A in validation country B is modelled as a function of post-grant fees and costs (costs for translation, validations, and renewals). We assume that translation costs increase with language distance and this effect is stronger for patents in which many claims need to be translated. A number of control variables describing the patent, the country of origin of the patent and the country for which protection is sought are also added. Our probit equation thus takes the form:[15]

$$\begin{aligned}\Pr(Validation) = \Phi(\beta_0 &+ \beta_1\, language\ distance_{AB} + \beta_2 \ln(no.\,claims) \\ &+ \beta_3\, language\ distance_{AB} * \ln(no.\,claims) + \beta_4\, validation\ \ fee_B \\ &+ \beta_5\, renewal\ \ fees_B + \sum_k \beta_{6k} controls) \qquad (1)\end{aligned}$$

[14] 59,992 patents were granted by the EPO in 2003, but 6,088 (or 10%) were not included in the dataset because they had not been validated in any of the EPC countries (the patent was withdrawn by the applicant after the decision to grant by the EPO).

[15] A Wald-test was employed to test if a log linear or a linear specification was more appropriate. The results clearly showed that the logarithmic specification was superior.

National patents derived from an EPO grant form international patent families[16]. Validation decisions within a family are connected to the initial patent. To account for the correlational structure within a patent family, we use a cluster estimator for adjusting the variance-covariance matrix of our probit estimator (Wooldridge, 2002).

3.2 Description of the variables

Dependent Variable

Patent validation. After grant, a European (EP) patent has to be validated in each state for which protection is sought, i.e., the patent has to be converted into a bundle of patents having the same legal status as patents granted through the national procedures.[17] In 2003, that is prior to the enforcement of the London Agreement in 2008, this required the filing of a translation of the patent specification, and the payment of national validation or publication fees within a specified term (Art. 65(1) EPC).[18] However, a validation has also been possible without filing a translation in the event the language of the official proceedings at the EPO has been (one of) the official language(s) of the validation country.[19] Furthermore, payment of a validation fee has not been required in some countries, such as Switzerland and Belgium.

The patent validation variable is defined as a dummy variable, taking the value one if a patent (granted by the EPO) of applicant country A has been validated in country B, and zero otherwise.[20] We infer the validation status from our data, assuming that a patent has been validated in a given country if *(i)* renewal fees are paid for the patent to the national patent office of the country and/or *(ii)* the patent lapses in the given country. In cases where patents lapsed within one year after grant (in all validation countries), the patents were considered as

---

16 Families include all patents filed abroad from an initial filing in a national patent office

17 Cf. http://www.epo.org/applying/european/validation.html (accessed on September 8, 2011).

18 Cf. http://www.epo.org/law-practice/legal-texts/epc.html (accessed on September 8, 2011). For a detailed description of the EP grant and validation procedure, see Harhoff et al. (2009).

19 An EP patent application must be filed in one of the official languages of the EPO, i.e. English, German or French, the so called procedural languages. Applications filed in other languages have to be translated into one of the three official languages within a term of three months. See http://www.epo.org/applying/basics.html (accessed on September 8, 2011).

20 The 20 Applicant countries include:: Austria (AT), Australia (AU), Belgium (BE), Canada (CA), Switzerland (CH), Germany (DE), Denmark (DK), Spain (ES), Finland (FI), France (FR), United Kingdom (UK), Ireland (IE), Israel (IL), Italy (IT), Japan (JP), Korea (KR), The Netherlands (NL), Norway (NO), Sweden (SE), USA (US) (selection criteria: minimum of 100 patents granted in 2003). The 17 countries of validation include: Austria (AT), Belgium (BE), Switzerland (CH), Cyprus (CY), Germany (DE), Denmark (DK), Spain (ES), Finland (FI), France (FR), United Kingdom (UK), Greece (GR), Ireland (IE), Luxembourg (LU), Monaco (MC), The Netherlands (NL), Portugal (PT), and Sweden (SE). Italy (IT) is not included due to the lack of information on validations in Italy. Broad estimates by the EPO suggest that 30 to 40 percent of the patents granted by the EPO are generally validated in Italy.

lapsed *ab initio* and were removed from the dataset. This is equivalent to assuming that these patents had never been validated in any country.[21]

<u>Explanatory and control variables:</u>

Linguistic distances. Distances are based on data collected in the 1960s by Dyen who collected words used in 95 Indo-European languages and dialects (Dyen et al., 1992). These speech varieties were classified into 'cognate classes'. The distance measure was calculated as the percentage cognate between language *A* and language *B*:

$$linguistic\ distance_{DYEN} = 1 - \frac{n_{AB}}{(n^0_{AB} + n_{AB})} \qquad (2)$$

where n_{AB} is the number of meanings for which *A* and *B* were classified as cognate and n^0_{AB} is the number of meanings for which *A* and *B* were not classified as cognate (For more information, see Ginsburgh and Weber, this volume).

Validation fee. The variable corresponds to the fee a patent holder has to pay to validate a granted patent in a member state of the EPC. Information on validation fees was extracted from the "Official Journal and the National Law Relating to the EPC".[22] The validation fee may comprise a fixed component and a variable (i.e. a page-based) component. However, most of the countries only charge a fixed fee. Some countries do not charge validation fees at all (Belgium, Switzerland, Luxembourg, Monaco, UK). For the countries which charge a page-based fee (Austria, Finland, Sweden, Denmark, and Spain) the average number of pages per patent, provided by the EPO, was used to compute the average total validation fees. Overall, the validation fees were calculated according to formula (2):

$$F_B^V = F_B^F + F_B^P \cdot \bar{S} \qquad (3)$$

where F_B^V denotes the validation fee for destination country B and F_B^F the fixed validation fee for country B, F_B^P refers to a the page-based fee if charged by country B, otherwise F_B^P is zero. $\bar{S}$ denotes the average number of pages per patent specification.

[21] When the lapse and renewal data sources contained conflicting results (0.66% of the cases) information on patent lapses were preferred over renewal information. The decision to prefer information on patent lapses was suggested by an EPO expert.

[22] Cf. http://www.epo.org/law-practice/legal-texts/epc.html (accessed on September 8, 2011).

Renewal fees. These fees have also been referred to as maintenance costs, i.e., costs to keep a patent valid for an additional year. With few exceptions, renewal fees increase with the year of renewal, but display considerable variation across countries. Renewal fees for the different years were again extracted from the "Official Journal and the National Law Relating to the EPC". Since we assume that the fees that have to be paid during the first years after grant matter most for the decision to validate a patent in a particular country, cumulative renewal fees for the years 4 to 6 from the date of filing of the application at the EPO are included in the regression. According to Harhoff and Wagner (2009), the average grant lag at the EPO amounts to about four years. Harhoff et al. (2009) show that during this three years period, 66.5 percent of all the patents belonging to a given cohort are granted.

GDP per capita and population. Annual data on GDP in current prices (US dollars in billions) and the population of the different countries in million capita were obtained from the World Economic Outlook Database as of September 2006. The data are published by the International Monetary Fund.[23] GDP per capita is taken as a proxy for the wealth of a country. The population variable is used as a proxy for the market size of a country.

Physical distance between capital cities. The physical distance between the capital cities of the applicant and the validation country was provided by Kristian Skrede Gleditsch, Department of Government, University of Essex.[24]

EPC membership duration (validation country). The average number of years of EPC membership of the validation countries was obtained from the homepage of the EPO.[25] The variable is included in the regression to test whether the duration of EPC membership reflects learning effects. As the transfer rate of domestic priority filings to the EPO increases with EPC membership (de Rassenfosse and van Pottelsberghe, 2007), one may expect that this duration also affects the probability that a patent is validated in a particular country.

Region of the applicant **-** Four dummy variables characterize the location of the applicants' home countries:

- US applicant
- Japanese applicant

[23] Cf. http://www.imf.org/external/pubs/ft/weo/2006/02/data/index.aspx (accessed on September 8, 2011). Since Monaco was missing in this database, GDP data were supplemented with data extracted from the United Nations Statistics Division (see http://unstats.un.org/unsd/snaama/dnllist.asp (accessed on September 8, 2011)). GDP data for Monaco were estimated based on the assumption that the level of GDP per capita is proportional to that of Luxembourg.

[24] Cf. http://privatewww.essex.ac.uk/~ksg/mindist.html (accessed on September 8, 2011).

[25] Cf. http://www.epo.org/about-us/epo/member-states.html (accessed on September 8, 2011).

- other non-European applicant: AU, CA, IL, KR
- European applicant: AT, BE, CH, DE, FR, UK, IE, NL, DK, FI, NO, SE, ES, IT

The latter forms the reference group. These regional dummies are used to account for unobserved heterogeneity between applicants from these country groups.

Number of claims at grant. To account for the size of a patent specification, the number of claims at the time of the grant is included in the regression. We treat the number of claims as a proxy for the overall number of pages that need to be translated, and thus as the scale factor in translation costs. Archontopoulos et al. (2007) show that there is a strong correlation between the number of pages included in a patent and the number of claims it contains.

Citations. It is likely that more relevant patents are validated in more EPC member states. We, therefore, include an additional variable accounting for the potential importance of the patent. In particular, we use the number of citations as a rough proxy for a patent's relevance (Gambardella et al., 2008). Since patents that are validated in many countries are more visible and may, therefore, also be more frequently cited by patent examiners, we use the number of citations a patent application received within three years after publication. The end of this time span will usually precede the grant of the patent so that we avoid endogeneity problems.

Patent portfolio (five years). The number of patents granted to the applicant(s) within five years before the grant of the focal patent is also used in the probit model. This 'portfolio size' variable accounts for the resources available to the applicants as well as to proxy their patenting experience.

Technical areas. Patent applications are classified according to 14 technical areas, known as "Joint Clusters" (JCs), used by the EPO since 2004 to assign patent applications to examiners.[26] As there is some factual and empirical evidence (van Pottelsberghe and van Zeebroeck, 2008) showing that some technologies (i.e., biotechnology and organic chemistry) are traditionally subject to a large geographical scope of protection, whereas others are validated in a very limited number of countries, the assigned area of technology may well affect the observed geographical scope of protection within the EPC.

[26] EPO Joint Clusters: Industrial Chemistry, Organic Chemistry, Polymers, Biotechnology, Telecommunications, Audio/Video/Media, Electronics, Electricity/Electrical Machines, Computers, Measuring Optics, Handling/Processing, Vehicles/General Technology, Civil Engineering/Thermodynamics, Human Necessities. See Archontopoulos et al. (2007) for additional information about the assignment of the IPC classes to the EPO joint clusters.

Technology position of validation vs. applicant country. To control for the relative technology attractiveness of the validation country, we include a variable that accounts for the technology position of the validation country (B) compared to that of the applicant country (A) by dividing the number of patents in technology *i* of the validation country (B) by the number of patents in technology *i* of the applicant country (A) during the five years before the grant of the patents, i.e. for the years 1998 to 2002.

$$technology\ position_{i,BA} = \frac{patents_{iB}}{patents_{iA}} \tag{4}$$

where $i = 1, \ldots, 30$ refers to the technical area of the validated patent based on the classification proposed by the French Patent Institute (INPI) and the ISI Institute of the Fraunhofer Gesellschaft (OECD, 1994). We expect that this measure will be positively associated with validation decisions, since a large production of patents in a particular technology in a potential target country is likely to indicate a large market for that technology in that country. Interviews with patent attorneys suggest for example that almost all patents applied for automotive technology target Germany as designation because this country constitutes one of the largest markets for automotive product and process technology. That, of course, is driven by strong domestic demand for the product itself.

4. Descriptive Statistics

The sample consists of 53,904 patents granted by the EPO in 2003. Table 2 summarizes descriptive statistics of the independent variables that are to be used for the multivariate analyses. The first group of variables provides information about the fees and costs that had to be paid to validate an EPO-granted patent in selected EPC member states and to keep the patent in force for the years 4 to 6 from the application date at the EPO. The Dyen language distance measure exhibits an average language distance of 0.46 varying between 0 (filing language equals language of the validation country) and 1 (distance between filing language and Finish).

Furthermore, Table 2 contains information about validation fees and renewal fees for the years 4 to 6 after application at the EPO. The average validation fee amounts to EUR 143.3. The cumulative early renewal fees for patents granted in 2003 amount to EUR 280 on average. Table 3 displays the validation fees and the early renewal fees of the 17 EPC member states contained in our sample for the year 2003. Switzerland, Monaco, Belgium, Luxembourg, and UK do not request a validation fee at all. The remaining countries request a fixed fee varying between EUR 25 (The Netherlands) and EUR 299 (Greece). Only five countries (Austria, Denmark, Spain, Finland, and Sweden) charge an additional page-based validation fee varying between EUR 10 (Spain and Finland) and EUR 25 (Austria) per page, once the number of pages exceeds a certain limit. Furthermore, Table 3 shows that all countries charge renewal fees (even if some countries only charge fees from year 5). The requested amount varies considerably between countries. Table A.3 in the appendix contains the renewal fees from year 3 to year 20 for all 17 countries.

Figure 1 summarizes renewal and validation fees for patents granted in 2003 categorized by translation cost groups. It clearly appears that validating and keeping a patent in force for the years 4 to 6 is more expensive in the Nordic countries and in Greece, especially due to the high translation costs. Translations into Nordic languages and Greek are most expensive. On the contrary, translations into Dutch, Portuguese, and Spanish are less expensive. German, English, and French are the least expensive languages in terms of translation costs. Out of the observed validations, 27 percent had to be translated into an expensive language, 19 percent into a less expensive language, and 28 percent into one of the least expensive languages. Furthermore, validating and keeping a patent in force for the years 4 to 6 is particularly expensive in Austria due to a high page-based validation fee (Austria charges a page based fee of 25 € per page in excess of five pages).

[Please insert Tables 2, 3 and Figure 1 about here]

The applicant countries have on average 127.5 million inhabitants; the validation countries exhibit an average of 19.2 million inhabitants. The mean physical distance between the capital cities of the applicant and the validation countries amounts to 4,173.2 km. The minimum physical distance amounts to 136 km (Belgium – Luxembourg), and the maximum to 18,044.0 km (Australia – Portugal).

5. Empirical implementation and results

Table 4 summarizes the results of four probit models[27]. Model 1 only contains the control variables. Model 2 adds the measure for translation costs, i.e. the linguistic distance. Model 3 adds the interaction between the linguistic distance and the number of claims which controls for the size of the patent applications. This number is highly correlated with the number of pages. Finally Model 4 exhibits the full model, i.e. also including validation and renewal fees. In the following – if not stated differently - the results of Model 4 will be described.

The results reveal that an increase of the linguistic distance by one percent decreases the probability of a validation by 15.9 percent. Model 4 also includes an interaction term "linguistic distances * no. of claims at grant" to account for the size of the validated patents. The effect of linguistic distances on the validation behavior is still negative and significantly different from zero, and the number of claims has a positive impact. The interaction term is negative and significantly different from zero which suggests that larger patents are less likely to be validated in countries with high translation costs. These results confirm our hypotheses 1a and 1b.

An increase in the validation fees by one percent leads to a decrease in the validation probability of 2.3 percent. Renewal fees reduce the probability of observing a validation in a country. A one percent increase in the renewal fees would lead to a reduction in the probability of validation of about 19.1 percent. Hence, hypotheses 2 and 3 are also confirmed by the data.

The control variables exhibit the expected signs. Model 4 shows that wealth of the applicant and the validation country has a significant impact on the probability of observing a validation. In particular, an increase in the GDP per capita of the applicant country (A) by one percent leads to an increase of the probability to observe a validation by 9.9 percent. An increase in the GDP per capita of the target country (B) by one percent raises the probability

[27] As a robustness check, we compared the determinants of validations over two grant years (2003 and 1995). To make a comparison of the two grant years reasonable, the two samples were built symmetrically with respect to potential validation countries. In particular, later entrants into the EPC (i.e. FI and CY) were excluded from the 2003 sample. Results are consistent with respect to the geographical context, languages, costs and fees. The only differences are that the wealth of the applicant country has a significantly negative effect on validations for the grant year 1995, whereas the effect is positive in 2003. A possible explanation of this difference may be that in recent years small applicant countries with a relatively low GDP per capita (e.g., ES, BE, and AT) validated more countries per granted EP patent (see Figure 2). Consistently, the distance between the capital cities of the applicant and the validation country has a negative impact. The coefficient decreases slightly from 1995 to 2003. Possibly, distances become less important over time, e.g., due to the internet and advancement of communication technologies. The complete results are available upon request.

of observing a validation by 37.3 percent. Both estimators are significantly different from zero at the one percent level. Applicants from richer countries have on average more income at their disposal to file patents abroad. The wealth of the destination country is assumed to attract more validations as demand conditions in the market are more attractive for firms.

The size of the applicant and of the validation countries – as measured by the number of inhabitants – also has a positive impact on the probability of a validation. The estimated parameters suggest that an increase in the population of the applicant country A by one percent increases the probability to observe a validation by 3.3 percent. An increase of the population variable of the validation country B by one percent increases the probability of a validation by 14.7 percent. The destination country's population positively affects the validation behavior as a large market is certainly more attractive than a smaller one, even after accounting for GDP per capita.

Overall, the results in Table 4 show that the wealth and size of the validation countries generally have a higher effect than the same characteristics of the applicant countries.

The parameter associated with the age of EPC membership is negative and significantly different from zero: the longer the EPC experience of a country, the lower the likelihood of a validation in that country. As expected, the technology position of validation countries in relation to that of the application countries has a positive and significantly different from zero effect on the validation behavior of the applicant country. The number of claims also shows a positive and significantly different from zero parameter: larger patents are filed in more countries. A possible explanation is that patent applicants and attorneys devote more efforts on promising filings, and that the number of claims, therefore, may be reflective of the patent's importance.

The variable capturing the physical distance between the applicant and the validation countries has a negative and significantly different from zero impact on the probability of a validation. Model 4 also shows the role of the geographical origin of the applicants. The probability of a validation is the lowest for the applicants originating from Japan and other non-European countries, and is the highest for applicants based in Europe. These results are in line with the findings of Guellec and van Pottelsberghe (2001) that large countries are less dependent on internationalization, since they already profit from large domestic markets.

Model 4 further contains variables measuring the value of the applications (forward patent citations) and the portfolio size of the applicant, as proxied with the number of patents granted to the applicants within five years before the grant of the underlying patents. Validations are more likely to occur for more valuable patent applications. In particular, a one percent increase in the value of a patent, i.e. a higher number of three-year citations, increases the probability of a validation by three percent. However, a one percent larger five-year patent portfolio of the applicants decreases the likelihood of a validation by 1.2 percent. In other words, patents of larger firms or of firms that hold more patents are characterized by a more focused geographical scope of protection. Firms with a larger patent portfolio are characterized by more selective market coverage.

[Please insert Table 4 about here]

EPO industry cluster dummies were used in all models as control variables. A Wald test conducted for each model reveals that the technical areas have a significant impact on the validation behavior of applicants. The parameters associated with industry clusters, estimated in Model 4, are shown in Table 14.4. The findings are consistent with the scope-year index put forward in van Pottelsberghe and van Zeebroeck (2008): patents in biotechnology and organic chemistry are validated in more countries and enforced longer than the patents filed for other technologies.

6. Concluding Remarks

The European patent system provides an interesting setting for the empirical analysis of patent systems. The variation in our data allows us to investigate to what extent patent applicants are influenced by fees and translation costs, as well as by physical distances between and market attractiveness of the validation country relative to the applicant country (represented by its size, its wealth or the technical position). Our paper analyzes a particularly clear decision-making situation where fees and translation costs are the only remaining expenses that separate applicants from patent protection.

Overall, the world may have become more globalized, but it certainly has not become “completely flat”. Physical distance still matters and so do distances in culture and languages. Our results regarding the impact of fees and translation costs provide important implications for patent policy makers. Costs and fees turned out to be important determinants of applicant behavior and may thereby be an important tool for policy changes. While rule changes in the patent system typically require long-lasting and complex decision-making processes, fee changes can be effective in the short run. Consequently, they should not be considered instruments safeguarding the treasury of patent agencies – they can affect and steer applicant behavior in a socially beneficial direction.

Language has always been a challenge for the European patent system, and especially for the setting-up of the Unitary Patent (van Pottelsberghe, 2011 and 2015). Translation requirements are the main reasons underlying Spain and Italy's drop out of the Unitary Patent project. So far, only 25 countries have ratified the Unitary Patent convention. The latter would be validated in all member states after its grants by the EPO upon request of the patent owner. This could constitute a solution to the issue of high translation costs. The "Translation Regulation" attached to the Unitary Patent indeed specifies that no further translation should be required after a transitional period of 12 years during which patents granted in German or French will need a translation into English and those granted in English will have to be translated into French and German (Council Regulation (EU) No 1260/2012). The Unitary Patent could alleviate the cost of translation in the future, once decisions about the structure of the renewal fees as well as the setting up of the Unitary Patent Court have been made.

References

E. Archontopoulos, D. Guellec, N. Stevnsborg, B. van Pottelsberghe de la Potterie and N. van Zeebroeck (2007) 'When Small is Beautiful: Measuring the Evolution and Consequences of the Voluminosity of Patent Applications at the EPO', *Information Economics and Policy*, 19, 103-132.

A. Arundel, (2001) 'The Relative Effectiveness of Patents and Secrecy for Appropriation', *Research Policy,* 30, 611-624.

K. Blind, J. Edler, R. Frietsch and U. Schmoch (2006) 'Motives to Patent: Empirical Evidence from Germany', *Research Policy* 35: 655-672.

D. Bosworth (1984) 'Foreign Patent Flows to and from the United Kingdom', *Research Policy,* 13, 115-124.

W. Cohen, R. Nelson and J. Walsh (2000) 'Protecting Their Intellectual Assets: Appropriability Conditions And Why U.S. Manufacturing Firms Patent (Or Not)', NBER Working Paper No. 7552.

Council regulation (EU) No 1260/2012 of 17 December 2012 implementing enhanced cooperation in the area of the creation of unitary patent protection with regard to the applicable translation arrangements (OJ L 361 31.12.2012 p89)

Y. Deng (2007) 'Private Value of European Patents', *European Economic Review,* 51, 1785–1812.

G. de Rassenfosse and B. van Pottelsberghe de la Potterie (2007) 'Per un Pugno di Dollari: A First Look at the Price Elasticity of Patents', *Oxford Review of Economic Policy,* 23, 1-17.

G. de Rassenfosse and B. van Pottelsberghe de la Potterie (2012) 'On the Price Elasticity of Demand for Patents', *Oxford Bulletin of Economics and Statistics,* 75, 58-77.

G. de Rassenfosse and B. van Pottelsberghe de la Potterie (2013) 'The Role of Fees in Patent Systems: Theory and Evidence', *Journal of Economic Surveys,* 27, 696-716.

I. Dyen, J.B. Kruskal and P. Black (1992) 'An Indo-European Classification: A Lexicostatistical Experiment', *Transactions of the American Philosophical Society* New Series 82, iii-132.

J. Eaton and S. Kortum (1996) 'Trade in Ideas Patenting and Productivity in the OECD', *Journal of International Economics,* 40, 251-278.

G. Friebel, A. Koch, D. Prady and P. Seabright (2006) Objectives and Incentives at the European Patent Office. Study Commissioned by the Staff Union of the European Patent Office (SUEPO). Available at http://idei.fr/doc/by/seabright/report_epo.pdf.

T. Friedman (2006) *The World is Flat – The Globalized World in the Twenty-First Century,* (London: Penguin Books).

A. Gambardella, D. Harhoff, and B. Verspagen (2008) 'The Value of European Patents', *European Management Review,* 5, 69-84.

V. Ginsburgh, W. Shlomo and S. Weyers (2011) 'The economics of literary translation: Some theory and evidence', *Poetics*, 39, 228-246.

D. Guellec and B. van Pottelsberghe de la Potterie (2001) 'The Internationalization of Technology Analyzed with Patent Data', *Research Policy*, 30, 1253-1266.

D. Guellec and B. van Pottelsberghe de la Potterie (2007) *The Economics of the European Patent System* (Oxford: Oxford University Press).

D. Harhoff, F. M. Scherer and K. Vopel (2003) 'Citations, Family Size, Opposition and the Value of Patent Rights'. *Research Policy*, *32*(8), 1343-1363.

D. Harhoff (2011) Deferred Patent Examination. München, Germany: Ludwig-Maximilians-Universität München, manuscript.

D. Harhoff, K. Hoisl, B. Reichl and B. van Pottelsberghe de la Potterie (2009) 'Patent Validation at the Country Level - The Role of Fees and Translation Costs'. *Research Policy,* 38, 1423-1437.

D. Harhoff and S. Wagner (2009) 'Modelling the Duration of Patent Examination at the European Patent Office', *Management Science*, 55, 1969-1984.

J. Lanjouw (1998) 'Patent Value in the Shadow of Infringement: Simulation Estimations of Patent Value', *Review of Economic Studies,* 65, 671–710.

OECD 1994. Using Patent Data as Science and Technological Indicators – Patent Manual 1994, Paris.

A. Pakes (1986) 'Patents as Options: Some Estimates of the Value of Holding European Patent Stocks', *Econometrica,* 54, 755-784.

A. Pakes and M. Schankerman (1984) 'The Rate of Obsolescence of Patents, Research Gestation Lags and the Private Rate of Return to Research Resources', In Z. Griliches (ed.): *R&D, Patents and Productivity* (Chicago: University of Chicago).

C. Peeters and B. van Pottelsberghe de la Potterie (2006) 'Innovation Strategy and the Patenting Performances of Large Firms', *Journal of Evolutionary Economics,* 16, 109-135.

M. Porter and S. Stern (2000) 'Measuring the "Ideas" Production Function: Evidence from International Patent Output', NBER Working Paper No. 7891.

J. Putnam (1996) *The Value of International Patent Rights*. PhD Thesis, Yale University.

J. Slama (1981) 'Analysis by Means of a Gravitation Model of International Flows of Patent Applications in the Period 1967-1978', *World Patent Information* 3(1): 2-8.

M. Schankerman and A. Pakes (1986) 'Estimates of the Value of Patent Rights in European Countries During the Post 1950 Period', *Economic Journal,* 96, 1052-1076.

N. Stevnsborg and B. van Pottelsberghe de La Potterie (2007) 'Patenting procedures and filing strategies', In D. Guellec and B. van Pottelsberghe de la Potterie (ed.) *The economics of the European patent system* (Oxford: Oxford University Press), 155-183.

J. Thomas (2010) *Deferred Examination of Patent Applications: Implications for Innovation Policy*. Washington, DC: Congressional Research Service Report 7-5700.

B. van Pottelsberghe de la Potterie (2011) ‘Europe should stop taxing innovation’, *World Patent Information*, 33, 16-22.

B. van Pottelsberghe de la Potterie (2015) ‘European Patent System’, *Encyclopedia of Law and Economics* (New-York: Springer Science+Business Media).

B. van Pottelsberghe de la Potterie and D. François (2009) ‘The Cost Factor in Patent Systems’, *Journal of Industry, Competition and Trade*, 9, 329-355.

B. van Pottelsberghe de la Potterie and M. Mejer (2010) ‘The London Agreement and the Cost of Patenting in Europe’, *European Journal of Law and Economics*, 29, 211-237.

B. van Pottelsberghe de la Potterie and N. van Zeebroeck (2008) ‘A Brief History of Space and Time: The Scope-Year Index as a Patent Value Indicator Based on Families and Renewals’, *Scientometrics*, 75, 319–338.

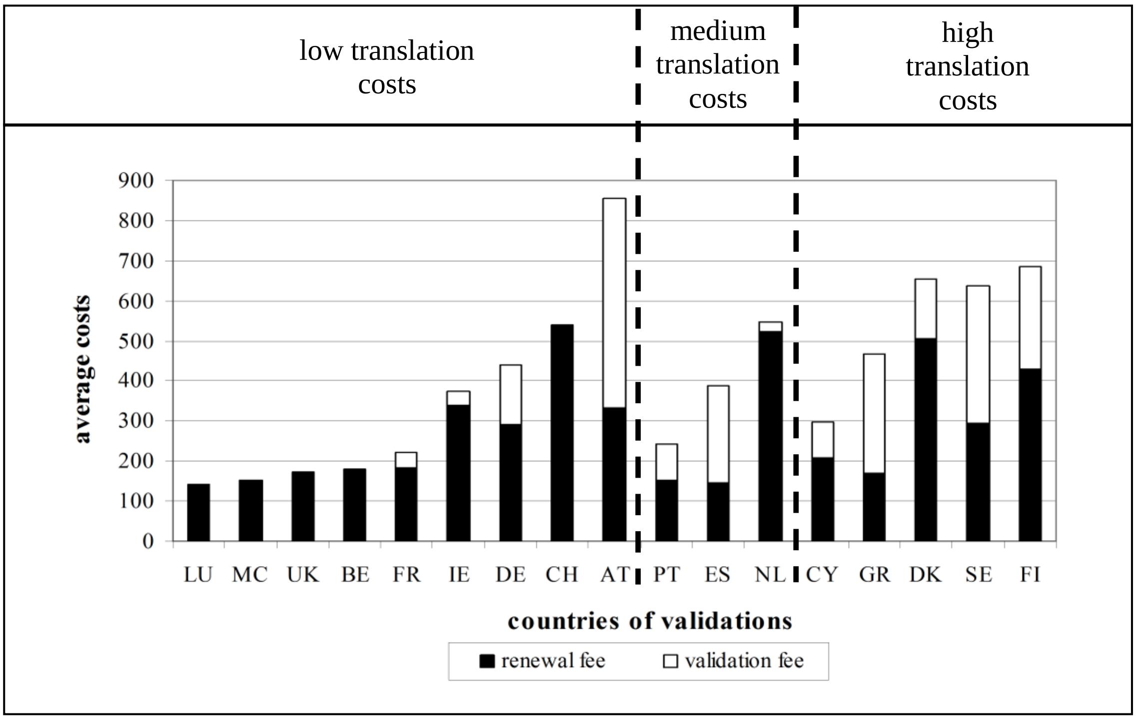
N. van Zeebroeck (2007) ‘Patents Only Live Twice: a Patent Survival Analyzis in Europe’, Working Papers Centre Emile Bernheim 07-028.

G. Von Graevenitz, S. Wagner and D. Harhoff (2013) ‘Incidence and Growth of Patent Thickets - The Impact of Technological Opportunities and Complexity’, *Journal of Industrial Economics* 61, 521-563.

J. Wooldridge, (2002) *Introductory Econometrics – A Modern Approach,* (OH: Thomson/ South-Western).

Tables and figures

Figure 1 Average costs (validation fees and renewal fees) to be paid to validate a patent in a particular member state of the EPC and to keep it in force for the years 4 to 6 (patents granted in 2003).



Note: Country abbreviations are provided in Table A.1 in the Appendix

Table 1 Members of the EPC as of October 2010

Date of entry into the EPC	Country	Date of entry into the EPC	Country
Oct 7, 1977	Belgium, Germany, France, Luxembourg, The Netherlands, Switzerland, United Kingdom	Dec 1, 2002	Slovenia
May 1, 1978	Sweden	Jan 1, 2003	Hungary
Dec 1, 1978	Italy	Mar 1, 2003	Romania
May 1, 1979	Austria	Mar 1, 2004	Poland
Apr 1, 1980	Liechtenstein	Nov 1, 2004	Iceland
Oct 1, 1986	Greece, Spain	Dec 1, 2004	Lithuania
Jan 1, 1990	Denmark	Jul 1, 2005	Latvia
Dec 1, 1991	Monaco	Mar 1, 2007	Malta
Jan 1, 1992	Portugal	Jan 1, 2008	Norway, Croatia
Aug 1, 1992	Ireland	Jan 1, 2009	Former Yugoslav Republic

			of Macedonia
Mar 1, 1996	Finland	Jul. 1, 2009	San Marino
Apr 1, 1998	Cyprus	May 1, 2010	Albania
Nov 1, 2000	Turkey	Oct 1, 2010	Serbia
Jul 1, 2002	Bulgaria, Czech Republ., Estonia, Slovakia		

Table 2 Descriptive statistics (N = 862,549 country pairs)

Variable	**Mean**	**Std.Dev.**	**Min**	**Max**
Language distance matrix (Dyen)	0.46	0.33	0	1
No. of claims at grant	12.57	9.07	1	247
Validation fees [€]	143.29	171.00	0	596.25
Renewal fees for years 4 to 6 [€]	280.07	140.06	143	540
GDP per capita: applicant country [1000 US$]	32.99	4.84	12.71	48.78
GDP per capita: validation country [1000 US$]	34.21	14.02	14.89	64.54
Population: applicant country [mio.]	127.52	101.87	3.98	291.00
Population: validation country [mio.]	19.21	23.65	0.03	82.52
Years membership EPC (validation country)	18.78	7.00	5	25
Physical distance between capital cities [km]	4173.17	3565.92	136	18044
Technology position applicant vs. validation country	0.70	6.44	0	2236
Origin of the applicant (0/1)				
Europe	0.54		0	1
US applicant	0.26		0	1
Japanese applicant	0.17		0	1
Other non-Europe	0.03		0	1
Citations	0.84	1.69	0	107
Patent portfolio (5 years)	252.10	551.77	0	2897

Table 3 Validation fees and early renewal fees for the year 2003

Country	Validation fee [Euro]♣		Renewal fee [Euro]♣		
	fix	page-based (pages free)	year 4	year 5	year 6
Austria	116	25 (5)	94	101	138
Belgium	0	-	45	60	75
Switzerland	0	-	0	270	270
Cyprus	87	-	52	70	87
Germany	150	-	70	90	130
Denmark	148	11 (35)	148	169	189
Spain	245	10 (22)	25	48	71
Finland	85	10 (4)	125	140	165
France	35	-	25	25	135
United Kingdom	0	-	0	72	101
Greece	299	-	46	54	70
Ireland	35	-	90	114	134
Luxembourg	0	-	37	47	59
Monaco	0	-	31	50	70
The Netherlands	25	-	0	242	279
Portugal	91	-	41	53	59
Sweden	120	17 (8)	76	98	120

♣ Source: Official Journal and the National Law Relating to the EPC; exchange rates: CA/D 1/03

Table 4 Multivariate analysis of patent validations for 2003 (marginal effects from robust probit regression)

	Model 1	Model 2	Model 3	Model 4
Fees and costs				
Linguistic distance		-0.175**	-0.109**	-0.159**
		[0.002]	[0.007]	[0.007]
Language distance			-0.028**	-0.015**
* claims at grant (log)			[0.003]	[0.003]
Validation fees (log)				-0.023**
				[0.000]
Renewal fees for years 4 to 6 (log)				-0.191**
				[0.001]
Geographical context				
GDP per capita of applicant country (log)	0.161**	0.131**	0.130**	0.099**
	[0.015]	[0.015]	[0.015]	[0.015]
GDP per capita of validation country (log)	0.266**	0.194**	0.193**	0.373**
	[0.002]	[0.002]	[0.002]	[0.003]
Population of applicant country (log)	0.037**	0.037**	0.037**	0.033**
	[0.002]	[0.002]	[0.002]	[0.002]
Population of validation country (log)	0.116**	0.121**	0.121**	0.147**
	[0.001]	[0.001]	[0.001]	[0.001]
Costs of business in the target country				
Years membership EPC of the applicant country (log)	0.041**	0.013**	0.013**	-0.056**
country (log)	[0.001]	[0.001]	[0.001]	[0.002]
Physical distance between capital cities (log)	-0.020**	-0.004*	-0.004*	-0.012**
	[0.002]	[0.002]	[0.002]	[0.002]
Technology position of validation vs.	0.151**	0.153**	0.153**	0.145**
applicant country (log)	[0.003]	[0.003]	[0.003]	[0.003]
USA (dummy)	-0.070**	-0.091**	-0.090**	-0.066**
	[0.007]	[0.007]	[0.007]	[0.008]
Japan (dummy)	-0.094**	-0.121**	-0.121**	-0.106**
	[0.005]	[0.005]	[0.005]	[0.005]
Other non-Europe (dummy)	-0.067**	-0.108**	-0.108**	-0.098**
	[0.009]	[0.008]	[0.008]	[0.008]
Other patent characteristics				
Number of claims at grant (log)	0.015**	0.016**	0.029**	0.023**
	[0.002]	[0.002]	[0.002]	[0.002]
Citations (log)	0.028**	0.029**	0.029**	0.030**
	[0.002]	[0.002]	[0.002]	[0.002]
Number of granted patents (5 years) (log)	-0.011**	-0.011**	-0.011**	-0.012**
	[0.000]	[0.000]	[0.000]	[0.000]
Control variables (see details in Table 14.4)				
EPO Industry Clusters (Wald test);	chi2(13)=	chi2(13)=	chi2(13)=	chi2(13)=
Reference group: Vehicles/General	5729.37	5760.68	5764.48	5850.82
Technology (dummy)	p=0.000	p=0.000	p=0.000	p=0.000
Observations	862,549	862,549	862,549	862,549
chi2(26)	62,209	72,091	72,018	78,048

Pseudo R2	0.231	0.238	0.238	0.262
log-likelihood	-397111.43	-393531.9	-393461.1	-381124.4

The dependent variable is ‘validation of a patent’ (=1 if a patent from a country A has been validated in country B; 0 otherwise)
Robust standard errors adjusted for intra-group EPO industry clusters in brackets / * significantly different from 0 at 5percent level; ** significantly different from 0 at 1percent level

Appendix

Table A.1 Country Abbreviations

Country	Abbreviation	Country	Abbreviation
Austria	AT	Ireland	IE
Australia	AU	Israel	IL
Belgium	BE	Italy	IT
Canada	CA	Japan	JP
Switzerland	CH	Korea	KR
Cyprus	CY	Luxembourg	LU
Germany	DE	Monaco	MC
Greece	GR	The Netherlands	NL
Denmark	DK	Norway	NO
Spain	ES	Portugal	PT
Finland	FI	Sweden	SE
France	FR	The USA	US
United Kingdom	UK		

Table A.2 Multivariate analysis of patent validations for 2003 (marginal effects from robust probit regression, standard errors adjusted for intra-group correlation)
Coefficients of the Technical Joint Clusters (Model 5) N = 862,549

	Model 4 Dprobit/dx
Dependent variable	Validation (0/1)
EPO Industry Clusters; reference group: Vehicles & General Technology	
Industrial Chemistry	0.108** [0.005]
Organic Chemistry	0.314** [0.006]
Polymers	0.118** [0.005]
Biotechnology	0.346** [0.007]
Telecommunications	0.011 [0.006]
Audio/Video/Media	0.025** [0.006]
Electronics	0.019** [0.005]
Electricity & Electrical Machines	0.019** [0.005]
Computers	0.018** [0.007]
Measuring Optics	0.026** [0.005]
Handling & Processing	0.076** [0.005]
Civil Engineering / Thermodynamics	0.024**

	[0.005]
Human Necessities	0.082** [0.005]
Pseudo R2	0.262

Robust standard errors in brackets / * significantly different from 0 at 5%; ** significantly different from 0 at 1%

Table A.3 Renewal Fees by Country and Renewal Year - 2008 [EURO]

♣ Source: http://www.epo.org/patents/law/legal-texts/html/natlaw/en/vi/index.htm

	3rd	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**	**11th**	**12th**	**13th**	**14th**	**15th**	**16th**	**17th**	**18th**	**19th**	**20th**
AT	70	150	150	150	270	270	270	500	500	500	850	850	850	1400	1400	1400	1400	1400
BE	35	50	65	85	100	125	145	170	195	220	250	290	330	370	410	455	500	545
CY	43	51.3	68	85	102.5	120	137	154	171	205	239	273	308	359	410	461.3	513	564
DK	67	148	168	188.5	215	242	276	310	343	377	411	444	485	525	565.5	605.9	646	687
FI	170	140	155	180	225	265	295	335	390	450	500	550	600	650	700	750	800	850
FR	36	36	36	72	92	130	170	210	250	290	330	380	430	490	550	620	690	760
DE	70	70	90	130	280	340	290	350	470	620	760	910	1060	1230	1410	1590	1760	1940
GR	0	0	54	70	84	98	114	134	154	184	214	242	272	322	358	392	430	472
IE	60	90	114	134	150	176	194	220	242	265	285	311	335	356	382	408	438	468
LU	29	37	47	59	74	89	104	118	130	145	160	175	190	205	220	235	250	270
MC	32	35	55	75	90	105	120	135	165	195	225	260	290	300	310	315	335	355
NL	0	40	100	160	220	280	340	400	500	600	700	800	900	1000	1100	1200	1300	1400
PT	43.5	53	64	85	98	114.5	137	172	201.5	229	275	320.5	366	412	458	504	549.5	595
ES	22	28	53	78	103	129	154	179	217	255	292	330	368	420	469	520	570	620
SE	36	73	93	114	140	166	197	233.5	259	280	296	316.5	342	368	394	420	446	467
CH	0	0	65	65	131	131	203	203	203	203	203	203	203	203	203	203	203	203
UK	0	0	67	94	121	147	174	201	228	255	281	308	335	362	402	442	482	536
IT	0	0	60	90	120	170	200	230	310	410	530	600	650	650	650	650	650	650

Note: Country abbreviations are provided in Table A.1 in the Appendix.

Bionotes

Dietmar Harhoff is Director at the Max Planck Institute for Innovation and Competition. At the Ludwig-Maximilian-University Munich (LMU), where he was Director of the Institute for Innovation Research, Technology Management and Entrepreneurship (INNO-tec), he is Honorary Professor for Entrepreneurship and Innovation as well as Director of the LMU Entrepreneurship Center, and, in 2014, also took over the Research Center for Entrepreneurship and Innovation. Harhoff's research focuses on issues in innovation and entrepreneurship, intellectual property and industrial economics. His research results have been published in a large number of book and journal articles. Besides advising several public and private organizations, he is the Chairmain of the Commission of Experts for Research and Innovation (EFI) of the German Federal Government and an elected member of the German Academy of Science and Engineering (acatech), of the German National Academy of Sciences Leopoldina and The Royal Bavarian Academy of Sciences.
(http://www.ip.mpg.de/en/pub/mcier/people/professors/harhoff.cfm)

Karin Hoisl holds a Minerva Fast Track Position (W2) at the Max Planck Institute for Innovation and Competition. Since November 2014, she has been holding a part-time professorship (Professor in the Economics and Management of Inventive Processes) at Copenhagen Business School, Department of Innovation and Organizational Economics. Between January 2011 and February 2015, she was Junior Professor of Invention Processes and Intellectual Property at Ludwig-Maximilians-University Munich (LMU), Germany. She conducts empirical research in Innovation, Entrepreneurship and IP Strategy. Her recent articles are published international scientific journals, including Management Science, Organization Science, Strategic Management Journal, and Research Policy.
(http://www.ip.mpg.de/en/pub/mcier/people/professors/hoisl.cfm)

Bruno van Pottelsberghe is Dean of the Solvay Brussels School of Economics and Management (SBS-EM), at Université Libre de Bruxelles. He is Full Professor and, as holder of the Solvay S.A. Chair of Innovation, he teaches courses on the economics and management of innovation and intellectual property. Bruno van Pottelsberghe was Chief Economist of the European Patent Office (EPO), from 2005 to 2007. He is Advisor to the President and Rector of the ULB for technology transfer issues since 2004 and is Non-Resident Research Fellow at Bruegel, a Brussels-based Think-Tank, since 2007. His research focuses on patent systems, the valuation of patents, and the role of IPRs. His recent articles are published in international scientific journals, including Research Policy, Journal of Public Economics, and Industrial and Corporate Change.
(http://www.ulb.ac.be/cours/solvay/vanpottelsberghe)

Charlotte Vandeput is PhD student at The International Centre for Innovation, Technology and Education Studies (*iCite*) of the Solvay Brussels School of Economics and Management at Université Libre de Bruxelles. Her research focuses on patent portfolio management and valuation.

WORKING PAPERS 2013

001 - Exploring europe's r&d deficit relative to the us: differences in the rates of return to r&d of young leading r&d firms - Michele Cincera and Reinhilde Veugelers

002 - Governance typology of universities' technology transfer processes - A. Schoen, B. van Pottelsberghe de la Potterie, J. Henkel.

003 - Academic Patenting in Belgium: Methodology and Evidence – M. Mejer.

004 - The impact of knowledge diversity on inventive performance at European universities – M. Mejer

005 - Cross-Functional Knowledge Integration, Patenting and Firm's Performance – M. Ceccagnoli, N. van Zeebroeck and R. Venturini.

006 - Corporate Science, Innovation and Firm Value, M. Simeth and M. Cincera

WORKING PAPERS 2014

007 - Determinants of Research Production at top US Universities – Q. David

008 - R&D financing constraints of young and old innovation leaders in the EU and the US – M. Cincera, J. Ravet and R. Veugelers

009 - Globalization of Innovation Production; A Patent-Based Industry Analysis – J. Danguy

010 - Who collaborates with whom: the role of technological distance in international innovation – J. Danguy

WORKING PAPERS 2015

011 - Languages, Fees and the International Scope of Patenting – D. Harhoff , K. Hoisl, B. van Pottelsberghe de la Potterie , C. Vandeput