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Multilingualism and the International Patent System: an Assessment of the Fairness of the Language Policy of WIPO

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Abstract This article provides an evaluation of the language policy of the World Intellectual Property Organisation (WIPO), by focusing on the reform enacted in 2008 when the Korean language was given the status of a language of publication of the Patent Cooperation Treaty (PCT). Results show that the 2008 reform entailed a reduction in the costs of access to the PCT procedures for Korean-speaking applicants of about 54%, generating about €24 million savings for them from 2009 to 2011. Further, the new language policy led to a more balanced distribution of admission and interaction costs among applicant countries. It is plausible that the 2008 reform has brought about a transfer of information costs from Korean-speaking countries to English-speaking countries and inventors fluent in English as a second language, but such negative effects have been offset by exogenous factors. This article shows under which conditions adding the Korean language could have had a positive impact on the cost-effectiveness of the language policy of the PCT system as well.

Keywords World intellectual property organisation · Patent cooperation treaty · Translation costs · Language policy · Korean language

JEL Classification H40 · H89 · K11 · O30 · O31 · O34 · O38 · O39 · O50 · P48 · Z18 · Z19

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1 Introduction[1]

The role of language policy in the area of Intellectual Property (IP) rights has remained relatively under-explored in the literature. The few existing contributions in this area focus most often on the estimation of translation costs to validate European patents granted by the European Patent Office (EPO),[2] or on the translation costs borne by applicants who enter into the national phase of the Patent Cooperation Treaty or PCT (WIPO 2008), which is administered by the International Bureau (IB) of the World Intellectual Property Organisation or WIPO.[3] Nonetheless, provisions determining the set of official languages of IP organisations and the related translation requirements (a.k.a. 'language regime' or 'language policy') do not affect exclusively the translation costs just mentioned. They also affect a whole range of language-related costs arising at different stages of the patenting procedures, from the moment in which a patent application is filed to opposition and appeal procedures. For example, applicants seeking IP protection may have to bear preliminary translation costs when they file an application with an IP authority if their working language is not one of the official languages of the authority concerned. The potential economic consequences of language regimes should not be underestimated. The language regime of the EPO, based on three official languages, namely, English, French and German, makes the average cost of accessing patenting procedures for European applicants whose first language is not one of these three languages at least 27% higher than the average cost borne by English-, French- or German-speaking applicants (Gazzola 2015). Besides, this generates the paradox that it is de facto cheaper for a US or Canadian company to file a European patent application with the EPO than it is for a Spanish or Polish inventor.

Generally speaking, language policies, just as is the case for any type of public policy, are a form of regulation whose effects must be evaluated (Grin 2003). This article aims at contributing to the research in technological innovation and IP rights by discussing some links between language policy and patenting, focusing on the PCT system. There are ten official languages (or 'languages of publication') of the PCT system, i.e. Arabic, Chinese, English, French, German, Japanese, Korean, Portuguese, Russian and Spanish. The most recent reform of the language regime of the PCT happened in 2008, when Korean and Portuguese were included in the languages of publication. It is therefore useful to provide an evaluation of this change, by discussing its costs and its effects on fairness. In line with the literature on economics and policy analysis, there is no particular moral or ethical content in the notion of fairness (Just et al. 2004). Assessing fairness simply implies identifying the distributive effects of a policy, that is, who loses, who gains and (if possible) how much, and how the costs of alternative policies are shared among individuals or groups. The main contribution of this article is to identify and clarify the distributive effects resulting from the addition of Korean to the languages of publication of the PCT.

[1] List of non-standard abbreviations: EPO (European Patent Office), EPC (European Patent Convention), International Bureau (IB), International Preliminary Report on Patentability (IPRP), International Search Authority (ISA), International Search Report (ISR), Korean Institute of Intellectual Property (KIPO), National phase entries (NPE), PCT (Patent Cooperation Treaty), Return on Fee Income Index (RFI), Representation Index (RI), Receiving Office (RO), WIPO (World Intellectual Property Organisation), Written Opinion (WO).

[2] See among others Van Pottelsberghe and Mejer (2010), Harhoff et al. (2009), Guellec and Van Pottelsberghe (2007).

[3] A partially related question regards the relationships between the presence of a common language and the frequency of collaboration between business partners (Dachsa and Pykab, 2010).

This article is organised as follows: Section 2 briefly describes the language regime of the PCT. Section 3 presents some unpublished data on the use of languages in the PCT system, showing that innovation is more multilingual than is commonly believed. In Section 4, I explain the analytical framework, and I identify the costs and the distributive effects of the language policy of the PCT. In Section 5, such effects are estimated. Section 6 critically discusses the empirical results obtained. The last section summarises and concludes the article.

2 Background: the Language Regime of the PCT System

The International Bureau of WIPO, or Secretariat, is responsible for managing the PCT. The IB is not a fully fledged patent office because it does not carry out the substantive examination of patent applications and it does not grant patents. Nevertheless, it performs several of the functions of traditional patent offices such as receiving international patent applications and publishing them. The IB is the central node of a complex network of IP authorities in the world that act at different stages of the PCT procedures. The language provisions of the PCT are strictly linked to patenting procedures, and they must be presented together.

Without going into details,[4] suffice to say that applicants file an 'International Patent Application' (or PCT application) with a Receiving Office (RO), typically a national IP authority (e.g. the US Patent and Trademark Office) or regional patent office (e.g. the EPO). The IB itself acts as a RO. One copy of the international application is kept by the RO ('home copy'), one copy ('record copy') is transmitted to the International Bureau, and another copy ('search copy') is transmitted to the competent International Searching Authority (ISA). ISAs carry out an 'International Search', that is, technical research of prior art. The result of the international search is the 'International Search Report' (ISR), a report containing citations of the relevant documents and a list of the fields searched. ISAs also issue a non-binding 'Written Opinion' (WO) as to the patentability of the invention. The WO is the basis for the issuance by the International Bureau, on behalf of the ISA, of the 'International Preliminary Report on Patentability' (IPRP). The IPRP is useful to national or regional offices during the substantive examination of the application carried out during the national phase. The IPRP is made available for public inspection after the expiration of 30 months from the priority date, typically at the beginning of the national phase. If the international patent application is not withdrawn, the IB publishes the international patent application together with the ISR no later than 18 months from the priority date, that is, the date of the filing of an international patent application or the date of the filing of a national or regional patent application if the applicant claims priority from such an application. The end of the PCT procedures coincides with the beginning of the 'national phase' in one or more states or regions designated by the applicants. The applicant files a national or regional patent application in the designated country or group of countries, and the competent patent office will carry out the substantive examination of the patent applications. If the invention is deemed industrially applicable (useful), new (novel), and it exhibits a sufficient inventive step (be non-obvious), the office will, conditional upon payment of different fees, grants a patent.

As regards to language requirements, the international patent application must be filed in a language permitted by the competent RO. If the application is not drafted in one of the languages of publication of the PCT, the applicant must translate it into one of these languages

[4] See, among others, Tritton and Davis (2014) for a more extensive discussion.

according to the RO rules. For example, an applicant files an international patent application with the Italian Patent and Trademark Office acting as a RO; this Office accepts international patent applications in English, French, German or Italian, and it designates the EPO (and only the EPO) as the competent ISA. As the official languages of the EPO are English, French or German, applications filed in Italian must be translated into one of these three languages. No further translation is required because English, French and German are also the languages of publication of the PCT. The ISR, the WO and the IPRP must be written in the same language and this language must be the language in which the international application will be published. The IB publishes the international patent application, the WO, the IPRP, the ISR and other relevant documents in the language of publication chosen by the applicant (and only in this language). If the ISR has not been drafted in English, the IB provides a translation into this language. The IB also provides a translation of the title and the abstract of all published international patent applications into English and French.

3 Dataset and Descriptive Statistics

If not specified differently, all tables and figures in this article have been elaborated directly by the author on the basis of a dataset kindly provided by the statistical unit of WIPO at the end of 2012. This dataset includes the country of origin of PCT applications, the language used for filing and the language of publication, the year of publication and the technological sector. In is worth noting that in our dataset counts are based on the patent publication date, that is, usually six months after the date of filing the international patent application or 18 months from the priority date. As there is a certain time lag between the moment of filing and the date of publication, the year of filing may not coincide with the year of publication. Applications filed but not published (that is, withdrawn applications) are disregarded, as they do not become part of existing knowledge. Unfortunately, WIPO does not provide data on the number of claims filed; only the number of PCT applications is known.

The PCT came into force in 1978. In that year, the IB published 19 PCT applications. In 2011, 163,669 PCT applications were published. During the last two decades, the number of international patent applications published per year has increased by 13% on average. Contrary to what is commonly believed (e.g. 'technology speaks English only'), the degree of linguistic diversity in the system has increased. In 1978, there were only five languages of publications, i.e. English, French, German, Japanese and Russian. Spanish was added in 1985, Chinese in 1994, Arabic in 2006 and Korean and Portuguese in 2008. Since 1998 applicants are allowed to file an international patent application in a language which is not a language of publication, but within one month they must provide a translation into one of the languages of publication designated by the competent RO. The main advantage of this reform is to allow inventors to file a patent application as soon as it is ready, thereby securing a priority date before actual or potential competitors.

Table 1 shows the percentage of PCT applications published from 1978, by the language in which the PCT application was filed. Only the first ten most important languages are considered. In order to track more recent trends, Table 1 also presents percentages from 2009 to 2011.

English, Japanese and German are the most frequently used languages in filing, reflecting the importance of the United States, Japan and Germany as countries of technological innovation. During the last decade, however, China and the Republic of Korea have also become intensive users of the PCT system. The rapid increase in the importance of Asian innovators is gradually changing the linguistic profile of PCT applicants. The percentage of published PCT applications that were originally filed in English, for example, has been steadily decreasing over the last 15 years (see Fig. 1). Only part of this trend can be explained as a result of the 1998 reform. After a peak in 1996

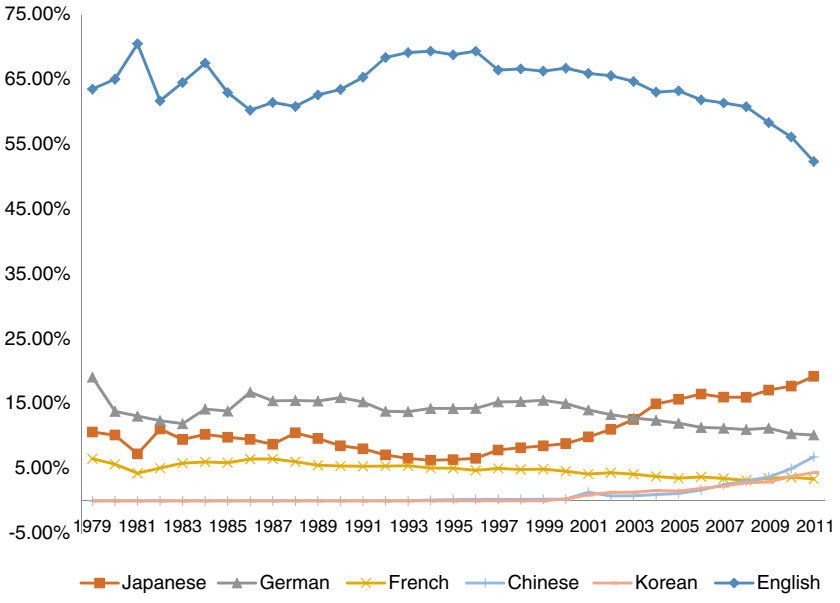
Table 1 PCT patent applications published, by language of filing. Top 10 languages. Results in percentage

Language	1978–2011	2009–2011
English	67.1	55.6
Japanese	15.6	18.0
German	13.3	10.6
French	4.3	3.5
Chinese	3.0	5.1
Korean	2.3	3.7
Swedish	0.8	0.2
Spanish	0.8	0.9
Russian	0.6	0.5
Italian	0.6	0.9

WIPO statistical database

(69.4%), the percentage of PCT applications filed in English decreased to 52.4% in 2011. In 2015, the percentage of PCT applications filed in English gradually approached 50% (WIPO 2015a).

By contrast, the role of Asian languages — and, although to a much lesser degree, other languages such as Spanish or Italian (which is not a language of publication) — is rising. The number of PCT applications published in 2011 that had been filed in Chinese or Korean is higher than those filed in French. In 2015, the share of international applications filed in Korean and Chinese was about 5% and 11% respectively (WIPO 2015a). The last percentage is higher than the share of PCT applications published in German (8%). While applicants from the Republic of Korea still use English quite often in filing (23% in 2011), Chinese and



Source: WIPO statistical database.

Fig. 1 Percentage of published PCT applications by language used in filing (1979–2011). WIPO statistical database. The list of the six most important languages used in filing is based on 2011 data

Japanese inventors indisputably prefer to file PCT application in the official language of the country in which they reside. In 2011, for example, only 6.9% and 7.9% of the PCT patent applications filed, respectively, by Chinese and Japanese applicants were in English (other languages are seldom used). German, and to a lesser extent French, are also important carriers of technical knowledge, even if during the last decades the share of published PCT applications that were filed in these two languages, in proportional terms, has declined more than the share of published PCT applications that were filed by applicants resident in, or nationals of, countries where French or German are official languages. The change in the language policy of the PCT that occurred in 2008 must be placed within the perspective of these trends.

Not surprisingly, international patent applications filed in a language of publication are published in the same language, whereas if they are filed in a language which is not a language of publication of the PCT (e.g. Swedish or Dutch), they are usually published in English. Before concluding this section, it is important to note that the figures presented in Table 1 are average values that do not fully highlight the complexity of multilingualism in the PCT system. Table 6 in the Appendix presents the percentage of PCT applications by technological sector, following the PCT classification, and by language of publication (as opposed to the language used in filing, as shown in Table 1). Table 6 shows that the importance of a language as a carrier of technical knowledge, measured by the percentage of PCT applications published in it, depends on the technological sectors considered. For example, from 2009 to 2011, 28.9% of all international patent applications published in the technological sector of 'digital communication' were in Chinese, whereas only 5.1% of all PCT applications on average were published in this language in the same period (see Table 1). Korean is particularly important in 'micro-structural and nano-technology' (9.8% of all PCT applications published between 2009 and 2011), Japanese in 'optics' (38.9%), German in 'mechanical elements' (29%) and English in 'pharmaceuticals' (80.3%). This has an important consequence: the linguistic needs of inventors seeking access to existing patent information and agents involved in patent intelligence depend on the technological area in which they work.

4 Analytical Framework: Characterising Costs and Distributive Effects

Public policies are usually evaluated in the light of standard criteria such as costs, effectiveness, efficiency (often interpreted as cost-effectiveness in applied research) and fairness (Just et al. 2004 ; Boardman et al. 2006). Language regimes can also be evaluated on the basis of such criteria (Grin and Gazzola 2013; Gazzola 2014). In this section, I assess the costs of the 2008 reform and its distributive effects (see Section 5 for a discussion of cost-effectiveness).

A distinction must be made between the primary and implicit costs of a language regime. Primary costs consist of the sum of the direct costs borne by the IP organisation considered (e.g. translation and interpreting services), plus the indirect costs such as a given share of common administrative structures, or overheads, directly associated with translation and interpreting services (either in-house or outsourced). Implicit costs (or external costs) are defined as language-related costs borne by individual inventors, companies, universities, and research organisations that arise from interacting with a patent office. Three types of implicit translation costs can be identified (Gazzola and Volpe 2014), i.e.:

- 'admission costs' are costs to translate patent applications into one official language of the patent office at the time of filing;

- 'interaction costs' are language-related costs connected to the flows of communication between patent applicants and third parties on the one hand, and the IP organisation considered on the other hand. Interaction costs, for example translations and interpreting, arise during intermediate communication, the procurement procedure, amendments to claims, and opposition and appeal procedures. Interaction costs are difficult estimate to because often they are part of the intermediation fees paid to patent attorneys, and therefore they cannot not measured separately (Van Pottelsberghe and François 2009: 339; Roland Berger 2004). Nevertheless, it would be misleading to ignore them;
- 'information costs' are related to accessing the existing patent literature which is available in a language that users either do not understand or do not speak fluently. Language-related information costs arise from monitoring the state of the art, freedom-to-operate analysis, patent intelligence, patent monitoring with the purpose of opposition (Gazzola 2015). Patent offices' language policy influences the process of knowledge diffusion because they determine in what language patent applications and patents must be published and possibly translated. This affects the diversity of languages in which the stock of new patent information is available to other inventors, that is, the features of one of the most important inputs on which inventors build innovation (Ceccagnoli et al. 2005; Guellec and Van Pottelsberghe 2007).

The empirical strategy followed in this article to compare the fairness of alternative language regimes consists of evaluating how the implicit costs of a language policy are distributed among applicants. In other words, equity is evaluated in terms of the distributive effects of a language regime on different groups of applicants, identified according to their first language in the case of a natural person, or to their main working language if one is dealing with a legal person such as corporations. A cautionary note is in order. Applied linguistics showed that corporate actors are not monolingual entities — even when they claim to have only one official language — but complex collaborative spaces where multilingual repertoires are used (see, among others, Berthoud et al. 2013). Nevertheless, the regulations of patent offices still define the language of applicants on the basis of the official language(s) of the state in which they reside or, alternatively, the state of which they are citizens (for example, see article 14 of the European Patent Convention — EPC). Although this criterion does not fully account for multilingual inventors, and it does consider that corporate actors do not have a mother tongue, it has an undisputed practical applicability. In this article, therefore, I do not exclude the possibility that corporations and research centres do not work in the official language of the country where they are based. Nevertheless, the existence of multilingual staff does not change substantially the usefulness of the territoriality criterion because working in a foreign language entails several types of costs that can be viewed as implicit costs. Multilingual staff is more expensive than monolingual staff (Grin et al. 2010), and editing the output of staff working in a foreign language is also a source of costs. Finally, drafting documents in a foreign language has an opportunity cost, because it usually requires more effort and more time.

5 Results: Evaluating the Fairness of the PCT Language Policy

As shown in Section 2, there have been four changes in the number of languages of publication in the PCT, but this article focuses on the 2008 reform and on the Korean language. The number of PCT applications filed in Portuguese is, in fact, still relatively low.

Table 2 Average global cost of access to the PCT system for a Korean-speaking applicant

Fees and admission costs	€
Transmittal fee	41
Average international filing fee	1093
Search fee	293
Admission translation costs	1700
Total	3127
Admission translation costs on total	54%

Table compiled by the author using the official fees published by WIPO in 2011 and European Commission (2011). The international filing fee charged by WIPO did not change between 2008 and 2011

5.1 Distributive Effects at the Entry Level

Table 2 presents the average global cost of filing a PCT application for a Korean-speaking applicant.

Transmittal fees are paid to the competent RO. In Table 2, the RO is the Korean Institute of Intellectual Property (KIPO). The international filing fee is paid directly to the IB, and it amounts to €1093.[5] The search fee is paid to the ISA and it does not become part of the budget of the IB. Table 2 reports the search fee charged by the KIPO as the ISA for an international search carried out in Korean. Following the estimations provided by the European Commission for the project of a European unitary patent (European Commission 2011, adapting Roland Berger 2004), the conservative assumption is made that the average patent application is made up of 20 pages, and that the average translation cost per page is €85. Hence, the average admission cost is €1700.[6]

The 2008 reform had a first distributive effect at the level of admission costs. Table 2 shows that admission translation costs for Korean-speaking applicants represent 54% of the general costs related to having access to the PCT procedures. After 2008, any inventor can file an international application in Korean without bearing these costs before publication, provided that the competent RO designates an ISA that accepts this language for the purpose of an International Search (e.g. the KIPO). From 2009 to 2011, 14,024 international patent applications were published in Korean. Hence, the total reduction of admission costs (and thus savings) for Korean-speaking applicants was about €24 million.

One could argue that these translation costs must be borne anyway if an applicant wishes to enter the national phase in at least one country whose official language is not Korean, such as the US or Japan. This argument is not fully convincing, however. First, international patent applications may be withdrawn before publication, for example, if the ISR reports bibliographical references that clearly point out that the invention is not novel. In this case, translation costs incurred before publication would be a deadweight loss. Second, a Korean-speaking applicant may choose the PCT route to 'buy time' — that is, to postpone the moment at which various fees for the substantial examination of the patent application, as well as the fees for granting and

[5] The filing fee is set at 1330 Swiss francs (the official currency of WIPO). This article adopts an exchange rate 1 Euro =1.216 Swiss francs, following the exchange rate used by the IB for its fees on the 1 December 2012.

[6] Other authors estimate a higher average number of pages of patent applications, for example, Van Zeebroeck et al. (2009), Van Pottelsberghe and Mejer (2010) and Archontopoulos et al. (2007). According to a report published by WIPO (2008), the average translation cost of an average patent are higher than €85 per page. However, the choice has been made to adopt the conservative assumption suggested by Roland Berger (2004). The cost estimate provided in this article, therefore, must be viewed as a lower bound.

renewing a patent, have to be paid — or to take advantage of the ISR and the WO in order to improve their application (or withdraw it) before a formal submission to a national or regional patent office (WIPO 2011). In both cases, if the applicant seeks protection only in the Republic of Korea or in a country in which the official language is not one of the languages of publication of the PCT, translating it into another language is a waste of resources for such an applicant.

5.2 Distributive Effects at the Level of Interaction and Information

The second distributive effect of the reform is a reduction of interaction costs for Korean-speaking applicants. Having received the ISR and the WO from the competent ISA that accepts Korean for the purposes of an International Search (the KIPO), the applicant can propose amendments in this language to the claims of his application before its publication by the IB. As the KIPO acting as ISA works both in Korean and English, the interaction costs for non Korean-speaking applicants have not increased since 2008. The only significant change has occurred at the level of the fee charged by the KIPO for the International Search (or 'search fee'). It is worth noting that search fees are set autonomously by each ISA and not by the IB of WIPO. Since 2009, the KIPO operating as ISA has considerably increased its fees both for searches carried out in English and for searches in Korean. The average search fee from 2006 to 2008 was €177, and the KIPO carried out the International Search only in English. Between 2009 and 2011, the average search fee was €686 for searches carried out in English, and €261 for searches carried out in Korean. Different factors can explain the difference between the two fees (about 62%). It is likely that producing the ISR and the WO in Korean rather than in English requires less effort from the local staff and that this may be reflected in the difference in the level of the fees. In addition, the International Searches in English are more likely to be requested by foreign applicants. In 2011, for example, the KIPO received 25,666 requests for PCT international search (KIPO 2015: 28); 38.8% were filed by Korean applicants, and 59.1% by American applicants (the KIPO is not a competent ISA for applicants filing a PCT application with the Japan Patent Office, the EPO and other national European patent offices acting as receiving office). All other things being equal, the choice of American applicants as to which ISA to choose for an International Search carried out in English is influenced by the relative level of the search fee charged by the KIPO *with respect to* other competent ISAs indicated by the United States Patent and Trademark Office acting as receiving office. Search fees charged by these ISAs are usually much higher than fee charged for searches carried out in Korean by the KIPO[7]; the KIPO, therefore, has an incentive to set a higher fee on the International Search carried out in English. It is not possible to know what search fee would have been charged by KIPO after 2008 if the reform had not taken place. The KIPO, for example, could have set a search fee equal to €686 for all applicants, or any intermediate value between €261 and €686. For this reason, it is risky to venture on estimates of the aggregate distributive effects of the new KIPO's search fee scheme.

The third distributive effect of the 2008 reform relates to the information costs. Quantifying such costs is more complicated than estimating the admission costs. International patent applications filed in Korean are published in this language, and they will no longer be translated into any of the previous eight languages of publication until the beginning of the national phase (if any) in countries in which Korean is not an official language. The first outcome of this is that information costs for all Korean-speaking applicants who wish to have direct access to applications published in this language drops to zero. The second outcome is

[7] Source: www.wipo.int/pct/en/fees.pdf.

an increase in the information costs borne by English-speaking inventors (native or non-native fluent in it) who do not speak Korean, unless a translation into English is made available at the beginning of the national phase. This is a consequence of the fact that between 1998 and 2008 the vast majority of PCT applications filed in Korean were eventually published in English and to a lesser extent in Japanese.

To our knowledge, no reliable data on the language skills of a representative sample of international applicants and inventors exist. Hence, it is not possible to estimate whether the reduction in information costs for Korean-speaking inventors is enough to offset the increase in the information costs borne by inventors who are proficient in English.[8] In order to provide a tentative quantitative assessment of the effects of the reform on the distribution of information costs among countries, I rely on two indicators. The first indicator is the *Representation Index* (RI_x) defined in Formula (1).

$$RI_x = \frac{A_x}{C_x}, \tag{1}$$

where (A_x) is the percentage of all international patent applications published in language X in a given period, and (C_x) the percentage of international patent applications published in the same period that were filed by residents or nationals of countries where X is an official language. An RI_x larger than 1 points out that the X-speaking countries benefit from an informative advantage, because the percentage of PCT applications published in language X is higher than the percentage of published international patent applications that were filed by individuals resident in, or nationals of, such countries.

The second indicator is the *Return on Fee Income Index* (RFI_x), defined in Formula (2).

$$RFI_x = \frac{A_x}{F_x}, \tag{2}$$

where (F_x) is the percentage of the fee income of the IB that can be ascribed to X-speaking countries. If the RFI_x is higher than one it means that, all other things being equal, the share of PCT patent information easily available to applicants who are resident in X-speaking countries is relatively higher than their contribution to the budget of the PCT. Recall that WIPO is a self-funding organisation; the international filing fee paid by applicants to have access to the PCT procedures (€1093, see Table 2) constitutes the bulk of the WIPO's budget.

The distributive effect of a language regime at the level of information costs in favour of X-speaking countries (D_x) is defined as an increasing function of RI_x and RFI_x.

$$D_x = f(RI_x, RFI_x) \tag{3}$$

Table 3 below shows the values of the two indicators for different groups of countries before and after the 2008 reform using a three-year time span (2006–2008 and 2009–2011). To keep the analysis tractable, only the top 25 PCT applicant countries are considered.[9] These

[8] As the knowledge of English in the Republic of Korea is more widespread than the knowledge of Korean in the English-speaking world, one may expect that, all other things being equal, the aggregate information costs have increased. For a discussion of the position of English as a foreign language in education in Korea, see Jung and Norton (2002). On the position of Korean as a foreign language in the US higher education institutions, see Furman et al. (2010). See European Commission (2012) for continental Europe.

[9] Countries are ranked according to the number of applications published in 2011. The list includes the United States, Japan, Germany, China, the Republic of Korea, France, the United Kingdom, the Netherlands, Sweden, Switzerland, Italy, Canada, Finland, Australia, Israel, Denmark, Belgium, India, Austria, Russia, Norway, Singapore, Ireland and Brazil.

countries make up 98% of all international patent applications published. Countries are grouped according to their official/national language. The first row includes six English-speaking countries (Australia, Ireland, Singapore,[10] the UK and the US and part of Canada),[11] the second row refers to four French-speaking countries (France and part of Belgium, Canada and Switzerland), and the third row includes four German-speaking countries (Austria, Germany and part of Switzerland and a small share of the Belgian population). For multilingual countries, using census data or other secondary sources,[12] the number of applications has been divided on the basis of the percentage of the population speaking official languages as their mother tongue. The last row ('others') includes all countries among the top 25 whose official language is not one of the PCT languages of publication. Arabic is excluded, as in practice it is not used.

The results reveal that the RI_x is much higher than one just for the English-speaking countries, meaning that English is over-represented. This entails a de facto form of implicit redistribution of the burden of patent information among linguistic groups that favours, in particular, the native speakers of English, confirming the problem of 'free-riding' in international communication (Grin 2005; Van Parijs 2007). The overrepresentation of the English language is due to the fact that several applicants who are resident in, or nationals of, non-English-speaking countries choose English as the language of publication for their applications because the official language of their country is not a language of publication of the PCT. Some applicants, for different reasons that cannot be explained here, lodge PCT applications in English even if they could use the official language of their country, e.g. German (see Gazzola 2014 for a discussion). One could argue that these applicants are likely to have an excellent command of English, and that a RI_x higher than one does not prove that the redistributive effect pointed out before is significant. Nevertheless, it is worth noting that published patent information is a global public good (Stiglitz 2007) that can be used by all actors potentially interested in such information and not only by former applicants, including individual researchers and staff working in small and medium enterprises who are not necessarily fluent in English.

The value of the RFI_x indicator is below one for all countries or groups of countries except for the English-speaking countries, and China and Russia. By contrast, the RFI_x is below one for all other countries. This indicates an implicit transfer of resources in favour of the group of English-speaking countries, and to a lesser extent in favour of China and Russia. Recall, nevertheless, that according to the PCT rules individual applicants who reside in Russia and China are entitled to a 90% reduction in their international filing fee.

The RI_x and the RFI_x for the Republic of Korea, the only Korean-speaking country included in our list, have obviously increased since 2008. The interesting result is, however, that the value of the RI_x and the RFI_x for the English-speaking countries has *not* decreased. Clearly, if Korean had not been given official status, the value of RI_x and RFI_x for English-speaking

[10] The government of Singapore recognises four official languages, that is, Malay, Mandarin, Tamil and English. The Singaporean government has adopted an English-medium education policy since the 1960s (Chua 2010). As a result, English is the language in which children acquire literacy.

[11] Results do not change substantially if New Zealand is added.

[12] For Canada, see Cardinal (2005).

Table 3 Representation Index and Return on Fee Income Index (2006/2008 and 2009/2011)

Group of countries or country/ language	RI (2006/8)	RI (2009/11)	RFI (2006/8)	RFI (2009/11)
English-speaking	1.54	1.60	1.52	1.57
French-speaking	0.63	0.60	0.63	0.59
German-speaking	0.82	0.79	0.81	0.78
Japan/Japanese	0.91	0.92	0.89	0.91
Spain/Spanish	0.78	0.78	0.77	0.77
China/Chinese	0.88	0.92	1.16	1.06
Russia/Russian	0.93	0.90	2.65	2.78
Korean/R. of Korea	-	0.57	-	0.56
Brazil/Portuguese	-	0.34	-	0.52
Other countries	-	-	-	-

Table compiled by the author

countries would have been higher. Yet, after the reform the value of these two indicators remained essentially stable. This can be ascribed to two factors. The percentage of PCT applications published in English has declined in percentage terms less than the percentage of published PCT applications filed by English-speaking countries. The second factor, related to the first one, is the increasing use of English as a language of filing by some non-English-speaking countries, especially the Nordic countries.

To conclude on this point, it is plausible that the 2008 reform has brought about a transfer of information costs from Korean-speaking countries to English-speaking countries and inventors fluent in English as a second language. Nevertheless, preliminary evidence based on the RI_x and the RFI_x indexes points out that the expected negative effect of the 2008 reform on the information costs borne by the English-speaking inventors (if any) has been offset by exogenous factors. It is worth noting that there are additional elements that can alleviate extra information costs for English-speaking inventors, i.e. translations into English of the ISR and of the IPRP, translations into English and French of the abstract and the title, machine translation, and translations provided by applicants to national or regional patent offices at the beginning of the national phase.

Table 4 summarises the results of this article. It focuses on the position of English-speaking countries because, as shown before, English was the language of publication most often chosen by applicants who filed PCT applications in Korean before 2008.

6 Discussion: the Trade-Off between Efficiency and Fairness Reconsidered

It is generally accepted that in public policies there is a trade-off between efficiency and fairness (Zajac 1995). One could argue that adding Korean to the set of languages of publication used by the PCT had a positive effect on equity, but that at the same time the reform had a negative impact on efficiency (or cost-effectiveness) because it has increased the primary costs of the language regime of the IB and it has added complexity to the system. Since 2008, in fact, the title and the abstract of the applications published in Korean must be translated into English and French at the expense of the IB, and the ISR, the WO and the IPRP must be translated into English. As before 2008 Korean applicants used to choose English as a language of publication, WIPO only had to provide translations into French of the abstract and

Table 4 Distributive effects resulting from the 2008 reform

Indicator	Effects on Korean-speaking applicants	Effects on English-speaking applicants
Cost for admission to patenting procedures	Decrease by €24 million between 2009 and 2011	No effect
Interaction costs with the IB of WIPO and the ISAs	Decrease	Not substantially affected, except for fees for an International Search carried out in English by the KIPO
Costs of access to existing knowledge	Decrease	Increase
Representation index	Increase from 0 to 0.57	Not substantially affected
Return of income fee index	Increase from 0 to 0.56	Not substantially affected

Table compiled by the author

title. The additional primary costs due to the 2008 reform for the IB can be estimated at €2.24 million, which will be rounded to €2.3 million to err on the side of caution.[13]

In this section, I question the universal relevance of the trade-off argument, and I explore under which conditions the 2008 reform could have increased the cost-effectiveness of the language policy of the PCT system. Adding new official languages can have a positive (rather than negative) effect on the cost-effectiveness of the language regime of the PCT system because it reduces the cost of access to the protection of IP rights for applicants who are proficient in that language. This, in turn, can increase the number of PCT applications filed, and consequently it can raise the fee income collected by WIPO by an amount that is high enough to cover additional primary translation costs.

The costs of patenting are one key variables companies take into account when they decide whether to patent an invention or not in one or more countries. A simple sequential model of firms' choices regarding whether to patent inventions or not is proposed in Arora et al. (2001), quoted in Guellec and van Pottelsberghe (2007). Firms' decisions are based on sequential choices in two stages, as shown in Fig. 2.

The inventor decides whether to invest resources in R&D in order to create a new invention at stage 1. At stage 2 the inventor chooses whether to patent it or to keep it secret. One must solve the model recursively starting from stage 2. The choice of the company regarding patent filing is based on a comparison between the expected profits from the commercial exploitation of the patent (P_B) with the expected profits if the patent is not obtained (P_N). Following Arora et al. (2001), I define the 'net gain' (NG) as:

$$NG = (P_B - C) - P_N \tag{4}$$

The difference (P_B-C) is the net profit (NP), i.e. the difference between the expected gross profit if the patent is granted and the sum of the various patenting costs such as the cost of drafting the application, administrative and legal fees, and the costs of enforcing a patent. If

[13] Between 2009 and 2011, the average unit cost for processing a PCT application was €655 (WIPO 2013). On average 29.6% of this cost can be attributed to translations (WIPO 2006). The actual additional unit translation cost of the 2008 reform is not €194, however. If applications in Korean had been published in English, the abstract would have been translated into French anyway. On average the price for an outsourced translation of an abstract into French from English is €34 (WIPO 2007b). Hence, the additional average unit translation cost per PCT applications filed in Korean can be estimated at €160. As from 2009 to 2011, 14,024 international patent applications were published in Korean, this yields €2.24 million of extra translation costs. Note that the corresponding decrease in admission costs for Korean-speaking applicants between 2009 and 2011 was estimated at €24 million, that is, ten time higher.

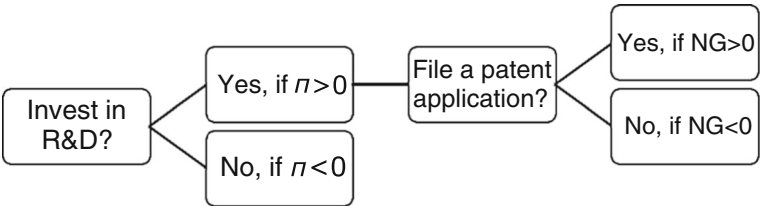


Fig. 2 Sequential choice model of innovation and patenting. Source: adapted from Guellec and van Pottelsberghe (2007)

(P_B-$C < P_N$) the expected net gain from patenting is negative, and therefore the company will not patent its invention. Turning to stage 1, the company invests in R&D if the expected profit from the invention (π) is positive, that is, if either NP or P_N are greater than zero. The company will choose its strategy so that the value of π will be equal to the largest value between NP and P_N. Formally,

$$\pi = Max(NP, P_N) \tag{5}$$

This simple choice model can be extended to take alternative patenting routes into consideration (respectively, the PCT route, the Paris route or the national route with the KIPO). In Fig. 3, I add a new stage to Arora et al.'s model in order to assess the effect of a reduction of admission translation costs on inventors' patenting choices.

In the extended version of the model, the net profit NP depends on the route followed. As a result the set of choices for profit maximisation is:

$$\pi = Max(NP_{\text{KIPO}}, NP_{\text{PARIS}}, NP_{PCT}, P_N) \tag{6}$$

The model shows that reducing translation costs associated with the PCT route to such an extent that P_N , NP_{KIPO} , NP_{PARIS}<NP_{PCT} and $\pi > 0$ can bring about two outcomes, that is, a net increase in the number of applications filed or a substitution effect. First, reducing admission costs would induce some inventors to patent their inventions rather than keep them secret or, alternatively, to invest in R&D to develop new inventions. The combined result of these effects may be a rise in the number of new PCT applications lodged. This contributes to the goals of the PCT, i.e., promoting innovation, contributing to the diffusion of technical knowledge and to a better protection of IP rights. The second outcome is a substitution effect. Applicants may decide to choose the PCT route rather than the Paris route to apply in more than one country, or they may opt for the PCT route rather than the national route. Although such a substitution does entail an overall increase in the total number of applications filed, it brings about different

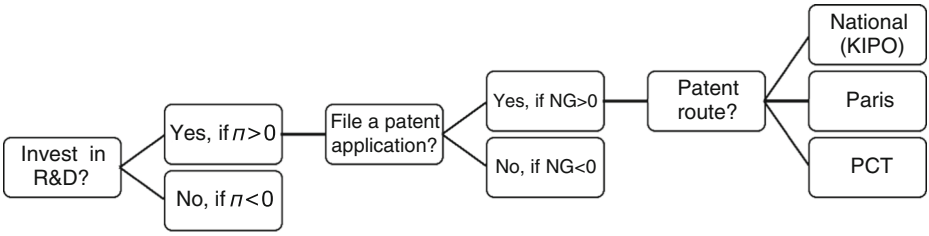


Fig. 3 Augmented sequential choice model of innovation and patenting

advantages in terms of the sharing of technical knowledge (i.e. applicants and patent offices of contracting states benefit from uniform formality requirements, international search, supplementary international search and preliminary examination reports, a centralised international multilingual publication, and a multilingual patent information system). These two effects are discussed in turn below.

An increase in the number of the languages of publication used by the PCT does not necessarily entail a *net* increase in the primary costs of a language regime, if such costs are outweighed by additional fee income due to a larger number of patent applications filed. WIPO is a self-funding organisation. Adding new languages to the set of existing languages of publication can entail an increase in the fee income of the organisation if the change of language regime brings about an increase in the use of the PCT system by applicants. This was indeed one of the strongest arguments put forward by the Republic of Korea in 2007 to convince the other PCT contracting parties to accept the inclusion of Korean in the languages of publication (WIPO 2007a).

There are some sound economic reasons behind this claim. Empirical evidence available for national or regional patent offices shows that, all other things being equal, a reduction of fees has a positive and significant impact on the number of new applications filed (see De Rassenfosse and Van Pottelsberghe de la Potterie 2013, for a review).[14] De Rassenfosse and Van Pottelsberghe de la Potterie (2012), for example, examined the demand for patents at the European, US and Japanese patent offices from 1980 to 2007 and carried out an econometric analysis through dynamic panel data models. They concluded that the long-term average fee elasticity of the demand for patents is −0.3.[15] Other studies, using different cross-section datasets converge towards a value around −0.5 (see De Rassenfosse and Van Pottelsberghe de la Potterie 2013).

Using patent fee elasticity as an estimate of the expected effects of a change of patenting costs on the number of patent applications filed and on innovation is a common practice in the literature (see, for example, Van Pottelsberghe and Mejer 2010, on the expected effects of an implementation of the London Agreement in the European patent system). By analogy, it is reasonable to assume that a reduction in admission translation costs can have a similar effect on the number of PCT applications filed because the cost of translating a patent application is an implicit type of fee. With the data at our disposal, it is not possible to estimate precisely which percentage of all applications filed by Korean applicants and published between 2009 and 2011 would not have been filed if Korean were not a language of publication. Nevertheless, the impact of a reduction of admission costs on the number of PCT applications filed can be estimated through a simulation. The number of PCT applications filed is used as a proxy for the innovation activities of a country. Only 0.4% of applications from the Republic of Korea, on average, have foreign co-applicants (WIPO 2015a: 42). PCT applications from the Republic of Korea, therefore, are essentially filed only by Korean-speaking inventors, and almost all PCT applications filed in Korean come from the Republic of Korea. In other words, the indicator used in this article to assess the effect of the 2008 reform reflects closely the innovation activities of the target population studied, i.e. Korean-speaking applicants.

[14] See also Van Pottelsberghe and Mejer (2010), Danguy and Van Pottelsberghe de la Potterie (2011), De Rassenfosse and Van Pottelsberghe de la Potterie (2012).

[15] A distinction is often made between short-term fee elasticity and long-term fee elasticity (see De Rassenfosse and Van Pottelsberghe de la Potterie 2013). The former refer to fee elasticity of patents within a 12-month period after the change in fees, whereas the latter refers to the value of the elasticity in a three or four-year period. For the purposes of this article, it is more appropriate to use the long-term fee elasticity.

Table 2 shows that adding Korean to the languages of publication in 2008 entailed a decrease of 54% in the general costs of accessing the PCT procedures for Korean-speaking applicants up to the beginning of the national phase. I assume an average value of the fee elasticity equal to −0.4, that is, the mean between the two values pointed out above.[16] Hence, all other things being equal, the number of PCT applications filed in Korean and published between 2009 and 2011 was expected to increase by 21.6% with respect to the three years before the entrance into force of the reform (2006–2008).[17] As from 2006 to 2008 the total number of published PCT applications that had been filed in Korean was 10,625, the predicted increase amounts to 2295 PCT applications. The question is how many additional PCT applications were necessary to cover the extra primary costs borne by the translation services of the IB linked to the inclusion of Korean as a language of publication from 2009 to 2011 (i.e. €2.3 million, see above). In order to generate such additional fee revenue during the period considered 2086 applications at the average filing fee of €1093 were necessary. The total number of published PCT applications actually filed in Korean between 2009 and 2011 was 17,416,[18] which is a remarkable result in comparison with world trends and taking the effects of the 2008 financial crisis into account.[19] 2086 applications represent 12% of 17,416.

In other words, if 12% of all applications filed in Korean and published between 2009 and 2011 had actually been lodged as a result of the reform, then the extra fee revenue collected by the IB would have been enough to cover the additional primary translation costs of the PCT language regime. As the number of additional PCT applications filed in Korean estimated on the basis of the patent fee elasticity (2295) is higher than the number of extra PCT applications needed to cover the extra-primary costs of the language regime (2086), it is plausible that the cost-effectiveness of the language regime of the IB improved. The extra primary costs of its language regime could have been offset by additional fee income, whereas the number of PCT applications in Korean (that is, the indicator of effectiveness used) increased.

[16] In two recent papers, the PCT Working Group estimated that the average fee elasticity for the PCT system is −0.0278, denoting a highly inelastic response of PCT filing volumes to variations in the international filing fee (WIPO 2014). The PCT fee elasticity is a bit larger for universities and public research organisations, especially in the developing countries (WIPO 2015b). Nevertheless, the PCT fee elasticity estimated in WIPO (2014) is computed using a model focusing exclusively 'on the choice between the so-called Paris route and the PCT route. It ignores the possibility that the PCT international filing fee affects applicants' decision on whether to seek patent protection beyond the office of priority filing' (WIPO 2014). In addition, the model 'ignores that the level of the PCT fee might affect applicants' decision on whether to file for patent protection to begin with' (WIPO 2015b). As shown later in this section, however, just a minority of PCT applications from the Republic of Korea are based on prior national applications, and after 2008 the PCT route has not replaced the Paris route for Korean applicants. For this reason, the estimation strategy adopted by the PCT Working Group does not fit with our analysis.

[17] I assume a linear progression in the effect of a reduction of fees on filing volumes. Hence, a 20% decrease in fees will have double the effect of a 10% fee change and half the effect of a 40% decrease.

[18] This number is higher than the number of PCT applications published in Korean (14,024) because some of the international applications filed in Korean were published in English between 2009 and 2010. This is due to the fact that these two years were a transitory period. After 2011, all PCT applications filed in Korean were subsequently published in Korean.

[19] To wit, the overall number of PCT applications filed in the world was 374,586 between 2003 and 2005, 472,817 between 2006 and 2008 (+26%), and 502,182 between 2009 and 2011 (+6.2%). The number of PCT applications filed with the KIPO was 11,112 between 2003 and 2005, 20,882 between 2006 and 2008 (+87%), and 28,077 between 2009 and 2011 (+34%).

One could argue that the observed increase in the number of PCT applications filed in Korean is due to a simple substitution effect between the Paris route and the PCT route or between the national patenting route at the KIPO and the PCT route. Putting it differently, the new PCT applications from Korean-speaking applicants would have been filed anyway with the KIPO following a strictly national route in the Republic of Korea or they would have been filed in other countries via the Paris route. This is the second possible effect of the reform predicted by the model of Arora et al. Nevertheless, I do not find strong evidence that such substitution effects took place. In contrast to other countries just a minority of PCT applications from the Republic of Korea are based on prior national applications. For example, the percentage of PCT applications claiming priority from a previous national patent application filed at the KIPO, on average, was 5% between 2003 and 2005, 4% between 2006 and 2008 and, finally, 3% between 2009 and 2011 (see WIPO 2015a). One would have expected an increase rather than a decrease of PCT applications claiming priority from a previous national patent application after 2008, but official figures do not support this claim. Further, the PCT route does not seem to have replaced the Paris route for Korean applicants after 2008. I define (x) the number of Korean PCT applications entering the national phase abroad (or 'National Phase Entries' — NPEs) and (y) the total number of patent applications filed abroad by Korean applicants, that is, the sum of NPEs and applications filed abroad via the Paris route. The ratio $(x)/(y)$ increased from 3.2% in 2001 to 28.8% in 2009, but then it remained relatively constant until 2013, as shown in Table 5. In other words, on average, there has been an increase in the use of the PCT system by Korean-speaking applicants with respect to the Paris route, but such an increase took place mainly before 2009.[20]

On the basis of the evidence available, it seems plausible that the addition of Korean to the languages of publication of the PCT in 2008 could have genuinely stimulated Korean-speaking applicants to use the PCT system more often than in the past by submitting a larger number of PCT applications that otherwise would have not been filed. It is worth stressing that the estimates presented in this section should be interpreted with caution. In order to isolate the effect of exogenous factors on the number of PCT applications filed, one would need data on language use by applicants that, to the best of our knowledge, do not exist, neither in the dataset of WIPO nor in PATSTAT. The purpose of this section, however, is not to provide conclusive evidence on this point, but rather to question the universal relevance of the trade-off between efficiency and fairness in patent procedures.

7 Conclusions and Policy Implications

This article compares two language regimes adopted by WIPO at different moments in time, that is, the language regime before and after 2008, when Korean (and Portuguese) were added as languages of publication of the PCT. Results show that the 2008 reform entailed a reduction in admission costs for Korean-speaking applicants of at least €24 million between 2009 and 2011 without increasing admission costs for other applicants. From this perspective, the reform increased fairness, in the sense that it reduced existing inequalities without any detrimental effect for other applicants. In addition, it reduced the

[20] Considering a certain time lag between the publication of a PCT application and the beginning of the national phase (see Section 2), it is more appropriate to refer to 2009 when evaluating the relationships between the reform and NPEs.

Table 5 NPEs on the total number of patent applications filed abroad by Korean applicants (2001–2013). Results in percentage

Year		Year	
2001	3.2	*2008*	25.3
2002	10.9	*2009*	28.8
2003	8.7	*2010*	28.4
2004	14.2	*2011*	28.0
2005	15.4	*2012*	30.4
2006	17.0	*2013*	29.1
2007	21.2		

WIPO statistical database and KIPO

interaction costs for Korean-speaking applicants. The reform also reduced the information costs for Korean-speaking applicants, but it entailed a transfer of information costs from them to English-speaking applicants and inventors. The overall impact on the aggregate information costs is ambiguous, but it probably increased. Nonetheless, our analysis shows that (i) the transfer of information costs from Korean-speaking applicants to English-speaking inventors due to the 2008 reform was actually a (partial) counterbalance for the implicit information cost savings from which English-speaking inventors had already benefited before 2008, and (ii) on aggregate this transfer was offset by exogenous factors. This article also discusses under which conditions adding the Korean language could be said to have had a positive impact on the cost-effectiveness of the language policy of the PCT system. It is worth stressing, nevertheless, that more data and further research are necessary to provide conclusive evidence on this point.

This article points out that the effects of linguistic regulations adopted by IP organisations are not negligible and the claim that multilingualism as such hampers technological innovation should be put under closer scrutiny. Obviously, this does not mean that the level of linguistic diversity in international organisations should tend towards the inclusion of all languages used on Earth. Nevertheless, an intermediate solution is probably wiser than aiming at monolingualism. In contexts where limiting the number of official languages can be justified by practical reasons, decision-makers could consider the possibility of designing a system of financial transfer to compensate those who must bear the implicit translation costs. The EPO, for example, applies a discount of 30% to several fees for applicants who are resident in a Contracting State of the EPC that does not share an official language with the EPO (e.g. Poland or Spain). WIPO could introduce a similar form of financial compensation to reduce the implicit costs borne by applicants who do not have a language in common with the PCT system. This could contribute not only to a more balanced distribution of costs among the contracting states of the PCT, but also to an increase in the cost-effectiveness of the language policy of the PCT as a whole.

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Compliance with Ethical Standards

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Appendix

Table 6 Languages in which international patent applications have been published between 2009 and 2011, by technological sector (according to the *International Patent Classification*)

Language	English	Japanese	German	French	Chinese	Korean	Other	
Field of technology								Total
I - Electrical engineering								
Electrical machinery, apparatus, energy	43.6%	28.8%	15.7%	2.8%	4.7%	3.3%	1.0%	29,489
Audio-visual technology	47.7%	35.3%	4.2%	2.1%	5.6%	4.6%	0.6%	17,284
Telecommunications	56.1%	18.9%	3.0%	2.1%	12.7%	6.7%	0.6%	15,778
Digital communication	55.0%	9.5%	1.5%	2.1%	28.9%	2.7%	0.4%	31,259
Basic communication processes	59.1%	25.5%	6.0%	3.1%	4.2%	1.5%	0.6%	3876
Computer technology	70.6%	15.5%	3.5%	2.4%	4.9%	2.5%	0.6%	30,294
IT methods for management	78.7%	9.2%	2.0%	1.4%	1.7%	6.2%	0.8%	6610
Semiconductors	48.6%	35.2%	7.5%	1.8%	2.3%	4.2%	0.4%	17,981
II - Instruments								
Optics	45.8%	38.9%	6.3%	2.4%	2.6%	3.2%	0.7%	13,057
Measurement	55.1%	18.9%	14.8%	5.5%	2.5%	1.8%	1.5%	19,748
Analysis of biological materials	78.3%	10.4%	4.3%	2.4%	1.0%	2.2%	1.3%	5439
Control	55.5%	16.5%	16.0%	3.9%	3.2%	2.4%	2.5%	6679
Medical technology	74.9%	10.4%	6.9%	2.3%	1.6%	2.2%	1.6%	31,705
III - Chemistry								
Organic fine chemistry	67.9%	13.0%	9.0%	4.2%	3.0%	1.8%	1.1%	16,493
Biotechnology	79.3%	9.7%	2.9%	1.9%	1.8%	2.4%	1.9%	15,751
Pharmaceuticals	80.3%	8.0%	2.7%	2.2%	2.8%	2.1%	2.1%	24,021
Macromolecular chemistry, polymers	52.4%	27.2%	12.6%	3.7%	1.5%	1.9%	0.7%	9001
Food chemistry	67.1%	16.3%	4.2%	2.9%	2.3%	3.5%	3.7%	4626
Basic materials chemistry	64.7%	15.4%	11.8%	2.7%	2.2%	1.9%	1.3%	14,211
Materials, metallurgy	42.2%	29.0%	13.5%	6.1%	3.6%	3.1%	2.6%	8848
Surface technology, coating	48.2%	30.9%	11.8%	3.7%	2.2%	2.1%	1.1%	7555
Micro-structural and nano-technology	62.9%	11.4%	10.1%	3.0%	1.0%	9.3%	2.3%	1055
Chemical engineering	59.0%	13.8%	14.9%	4.9%	3.0%	2.4%	2.0%	11,064
Environmental technology	52.9%	20.0%	12.8%	5.6%	2.8%	3.3%	2.5%	6855
IV - Mechanical engineering								
Handling	58.0%	14.1%	16.3%	4.1%	2.4%	2.5%	2.5%	11,442
Machine tools	43.6%	21.6%	23.8%	3.7%	3.4%	2.3%	1.6%	8710
Engines, pumps, turbines	43.4%	18.5%	23.2%	6.6%	3.3%	2.2%	2.7%	13,741
Textile and paper machines	55.0%	19.5%	16.5%	2.5%	3.3%	2.1%	1.1%	6100
Other special machines	54.7%	17.3%	14.8%	5.3%	2.2%	2.8%	2.8%	11,974
Thermal processes and apparatus	47.8%	19.9%	15.7%	4.5%	5.8%	3.7%	2.6%	7412
Mechanical elements	42.0%	18.6%	29.0%	4.6%	2.7%	1.6%	1.6%	12,637
Transport	40.2%	18.5%	24.3%	9.3%	2.8%	2.7%	2.3%	17,586
V - Other fields								
Furniture, games	61.2%	9.3%	12.0%	3.7%	5.6%	5.3%	3.1%	9578
Other consumer goods	57.2%	11.2%	14.1%	4.2%	4.0%	6.3%	3.0%	9174
Civil engineering	66.6%	5.8%	12.5%	4.2%	3.6%	3.7%	3.6%	13,595
Average	58.2%	18.0%	10.6%	3.5%	5.2%	3.0%	1.5%	

WIPO statistical database

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