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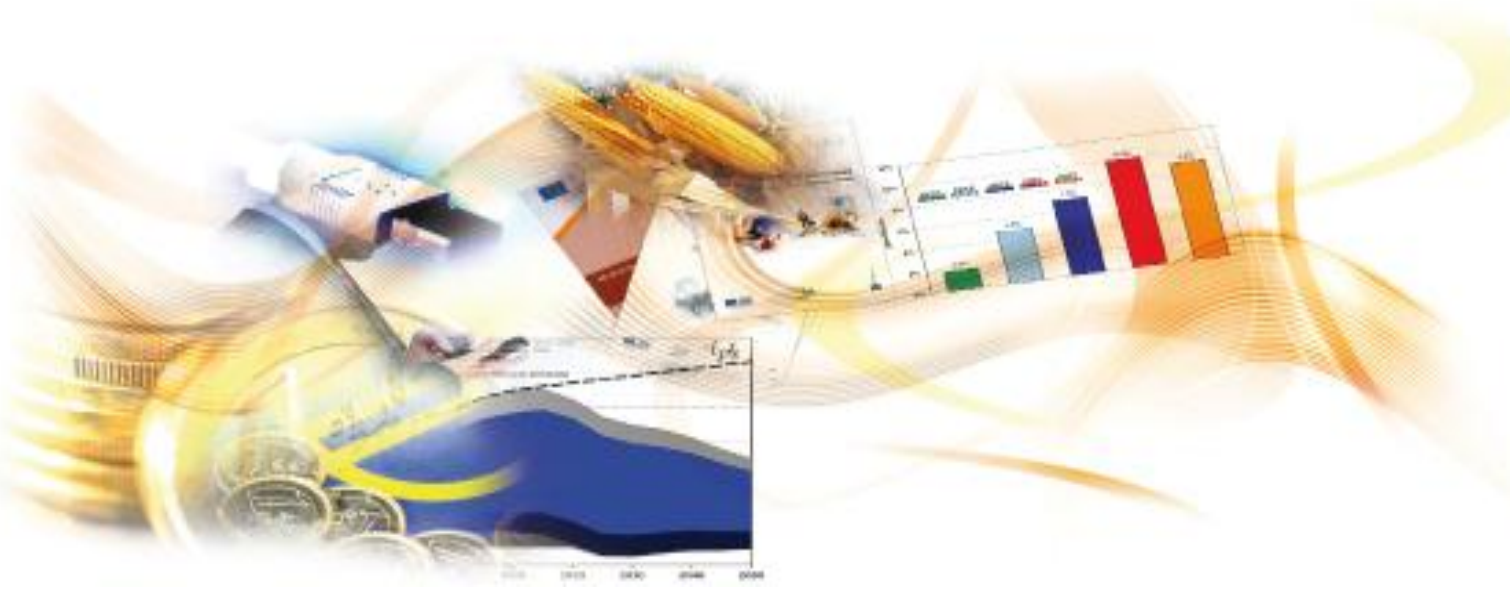

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International patenting strategies in ICT

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Preface

The European ICT Poles of Excellence (EIPE) research project at the Institute for Prospective Technological Studies is investigating the issues of growth, jobs and innovation, which have become main priorities of the European Union's growth strategy programme 'Europe 2020'.

The overall objectives of the EIPE project are to set the general conceptual and methodological conditions for defining, identifying, analysing and monitoring the existence and progress of current and future EIPE, in order to develop a clear capacity to distinguish these among the many European ICT clusters, benchmark them with non-European poles, observe their dynamics and offer a thorough analysis of their characteristics.

The EIPE project started late in 2010 and has, since then, developed a large database of original ICT innovation indicators, enriched with geographical information in order to allow localisation and aggregation at NUTS 3 and NUTS 2 level. The tool helps us to answer such questions as: How is ICT innovation and economic activity distributed and how is it evolving in Europe? What locations are attracting new investments in ICT R&D or manufacturing? What is the position of individual locations in the global network of ICT activity?

To date, the following additional publications have emerged from the research:

- A Framework for assessing Innovation Collaboration Partners and its Application to BRICs. G. De Prato and D. Nepelski, JRC-IPTS Working Paper, (2013).
- The global R&D network. A network analysis of international R&D centres, G. De Prato and D. Nepelski, JRC-IPTS Working Paper, (2013).
- Does the Patent Cooperation Treaty work? A Global Analysis of Patent Applications by Non-residents. G. De Prato and D. Nepelski, JRC-IPTS Working Paper, (2013).
- Internal Technology Transfer between China and the Rest of the World. G. De Prato and D. Nepelski, JRC-IPTS Working Paper, (2013).
- Asia in the Global ICT Innovation Network. Dancing with Tigers, G. De Prato, D. Nepelski and J.-P. Simon (Eds), Chandos Asian Studies Series: Contemporary Issues and Trends, Chandos Publishing, (2013, forthcoming),
- Global technological collaboration network. Network analysis of international co-inventions, G. De Prato and D. Nepelski, Journal of Technology Transfer, 2012,
- Internationalisation of ICT R&D: a comparative analysis of Asia, EU, Japan, US and the RoW, G. De Prato and D. Nepelski, Asian Journal of Technology Innovation, (2012),
- A network analysis of cities hosting ICT R&D, G. De Prato and D. Nepelski, (2013 - forthcoming).

More information can be found under: http://is.jrc.ec.europa.eu/pages/ISG/EIPE.html

Table of Contents

1. Introduction

A high-tech global technology company, such as Microsoft, earns more than 50 percent of its revenue in overseas markets (Phelps, 2005). Like Microsoft, any business involved in global operations must deal with the fact that whereas economic activity tends to be increasingly borderless, there is no global patent system and significant differences between national patent systems exist (Lerner, 2002; van Pottelsberghe de la Potterie, 2011). A company that seeks protection in a particular market needs to obtain it within the jurisdiction of the corresponding country. Although a firm can derive substantial benefits from patents (Macdonald, 2004), the associated costs and barriers are substantial (Hall & Harhoff, 2012). Hence, a firm faces a dilemma with respect to the potential benefits of protecting its invention or technology in a foreign market, on the one hand, and the costs to bear to obtain patent protection and enforcing it under a foreign jurisdiction, on the other hand (Cockburn, MacGarvie, & Müller, 2010; Geradin, Layne-Farrar, & Padilla, 2012; Moy, 1993; Pagano, 2007). Although a home-bias exists, i.e. applicants tend to file for patent protection in their home markets (Dernis & Khan, 2004), rapidly growing international commerce is intensifying cross-border competition and forcing firms from technology intensive sectors such as in information and communications technologies (ICT) to protect their inventions in foreign markets. The result is a recent surge in international patent filings, which today account for about 50 percent of total patent applications (WIPO, 2011b).

This paper deals with the issue of international patent filings in ICT, and aims to provide answers to questions about the drivers behind this increasingly important phenomenon. We study the factors behind the motivations of non-resident applicants to file an application for patent protection under foreign jurisdictions.

In our analysis, we use PATSTAT, a comprehensive dataset provided by the European Patent Office (EPO), which contains information on the global population of 71 million patent applications submitted to around 180 patent offices in the world. Of these applications, we consider more than 28.6 million for the period between 1990 and 2007. We construct bilateral measures of foreign patent applications for all countries that are both sources of patents and destinations for foreign applicants seeking patent protection abroad. In order

to cast new light on the factors driving the international patenting in ICT, we apply a gravity model.

The issue of international patenting has already attracted the attention of scholars. For example, Eaton et al. (1998) address this topic to study how countries specialize and which technologies are most mobile. Paci, Sassu and Usai (1997) proceed in a similar way. Their study is concerned with a comparison of national innovation systems and they use patent statistics to measure a country's technological performance. Because of its scope, it is limited to only six countries and does not address the issue of the applicants' motivations for seeking patent protection in a foreign country. In contrast to our approach, they track technology production specialization patterns across countries and the issue of cross-border technology transfer. Moreover, by using inventor-based counts of patents, they focus on innovation productivity. Our work, however, relies instead on applicant-based counts of patents, which direct attention towards patenting strategies of business entities seeking protection for inventions for which they own property rights.

Guellec & Van Pottelsberghe de la Potterie (2002) also explore the issue of international patenting. However, the focus of their study lies in the question of how the combination of designated states for protection, together with other characteristics of a patent application, affect the probability of a patent application being granted. The issue of international patenting was also addressed by some studies on technology diffusion (Eaton & Kortum, 1999; Hafner, 2008). The main difference between these studies and the approach applied in this study is that they address the issue of technology transfer, rather than that of the motivations of international competition and the drivers of international patenting.

A study by Sternitzke (2009) is closely related to ours, both in terms of the question and the focus on one technology field: telecommunications and audiovisual technology. However, the geographic (it considers China and Japan) and technological scope of the study is relatively narrow. Thus, our work offers a much more comprehensive analysis of international patenting in ICT.

Considering the above, an important contribution of the current study is that it covers all the countries that are present on the map of patenting activity and uses bilateral measures of cross-country patenting as a unit of observation. Thus, in contrast to the majority of the previously mentioned works, it does not rely on aggregate measures of incoming or

outgoing foreign patent applications to a country, which neglects the differences in bilateral relationships between countries. Moreover, it is not limited to a sub-sample of countries. Instead, by taking a global view of the issue of international patenting and covering all the involved countries, we expand our understanding of the issue of international patenting activity in ICT.

The rest of the paper proceeds as follows: Section 2 describes the gravity model of international patenting. Section 3 introduces the data and measures used in the study. Section 4 presents and discusses the results of empirical estimations. Section 5 concludes.

2. Model of international patent filings

In this paper we are interested in addressing empirically the question of what factors are behind applicants' motivations in seeking for protection for ICT inventions under foreign jurisdictions. In order to carry out our analysis, it would be useful to adhere to a model that specifies what determines international patent filings. Unfortunately, to our best knowledge, there are not fully adequate theoretical models dealing with this issue. The closest theoretical concept suitable for an empirical analysis of international patenting is the gravity model of trade, which, besides having been widely used in the studies of international trade (De Benedictis & Tajoli, 2011), has already found its way to study other types of bilateral relationships between countries, e.g. technological collaboration (De Prato & Nepelski, 2012; Dominique Guellec & Van Pottelsberghe de la Potterie, 2001). Thus, we believe that the gravity model allows us to formulate predictions concerning the determinants of international patenting, i.e. why applicants seek patent protection abroad.

In its straightforward form of international trade, the gravity model predicts that the formation of a link between any pair of countries is a function of geographical proximity and their economic size. In its extended form, other variables are included, e.g. cultural or technological proximity. Taking this theoretical prediction as a starting point, we proceed with formulating a model in which we expect that a country's attractiveness for foreign applicants depends on some of its characteristics. To identify these characteristics, we derive a set of factors that are used in studies conceptualising the issue of international trade, the internationalisation of innovation and international technology transfer (Arora, Fosfuri, & Gambardella, 2001; De Benedictis & Tajoli, 2011; Dunning, 1994; Head, Mayer, & Ries, 2010; Kuemmerle, 1999; Macdonald, 2004). As a result, besides geographic and

cultural distance, we include a number of other explanatory variables that can be grouped into two main blocks: economic capacity and inventive capacity of a country. In addition, we include a measure related to the length of a country's Patent Cooperation Treaty (PCT) membership, which captures the potential decrease in burden on an applicant who seeks patent protection in a foreign country. Thus, a function that is expected to capture the relationship between the propensity to file patent applications by applicants overseas can be expressed as follows:

$$IntApp_{ijt} = f(CommLang_{ij}, Dist_{ij}, GDP_{it}, GDP_{jt}, FDI_{jt}, ICTinv_{it}, ICTinv_{jt}, PCT_{jt}, \alpha, \varepsilon_{ijt}) \quad (1)$$

where $IntApp_{ijt}$ represents the count of patent applications filed by applicants residing in country *i* to the national patent office of country *j* in $t \in (1990,2007)$. Unobserved time and country effects are captured by ε_{ijt}.

Concerning the geographical proximity, we use a variable controlling for the distance between countries *i* and *j*, $Dist_{ij}$. In addition, in order to account for other frictions in the process of international patenting resulting from cultural or, to some extent, institutional differences, we include a dummy variable $CommLang_{ij}$, which indicates whether two countries share a common official language. We expect this variable to be highly relevant considering the burden of patent enforcing efforts in a foreign country.

Regarding the economic size of countries whose foreign patent offices non-resident applicants submitted patents to, information on GDP (in current US$) of country *i* and *j* in period *t* is included. Altogether, as discussed above, measures of a country's GDP are expected to capture the economic prowess of a country of an applicant, on the one hand, and the attractiveness of the market in which patent protection is sought for, on the other hand. In addition, in order to control for the openness of a country to internationalisation of economic activity, we also include measures of foreign direct investment FDI_{jt}, referring to a country in which a foreign applicant seeks to protect his invention (in current US$).

Following our expectations that not only distance hinders and economic factors motivates applicants to commercialize their technology and know-how in overseas markets, variables $ICTinv_{it}$ and $ICTinv_{jt}$ control for the innovation capacities in the field of ICT of both countries by the total number of patents in ICT of country *i* and *j* at time *t* with. This way

we expect to capture both technological proximity, and the potential competition that a firm from country *i* can face in country *j*.

Finally, to address the issue concerning the working of the patent system and the high costs of international patenting, we measure the duration of a country's membership in the PCT by PCT_{jt}. The PCT is one of the major undertakings in the process of patent harmonization. The treaty came into force in 1978 and today has 145 signatory countries (Lerner, 2002, 2002a). It is an international treaty for rationalization and cooperation with regard to the filing, searching and examination of patent applications and the dissemination of the technical information contained therein. The PCT does not give the right to "international patents" and the task of and responsibility for granting patents remains exclusively in the hands of the national patent offices in which protection is sought for, i.e. designated countries. We expect that the introduction of this procedure would have a positive impact on the level of international patenting activities and that filing a patent application through the PCT procedure would offer an advantage to foreign applicants wishing to seek protection in their markets, as compared to countries that are not PCT members.

3. Indicators and data sources

Measure of international patent filings

Computing patent statistics is far from being a straightforward task. In order to complete the dataset necessary to investigate applicants' strategies in ICT, we had to go through three main steps, which we describe in detail below.

Identifying ICT patents: With regard to the identification of ICT patent application technology classes, we considered the taxonomy of the International Patent Classification (IPC) technology classes proposed by the OECD (OECD, 2008b). The mentioned taxonomy links four categories of ICTs to groups of technology classes, i.e. Telecommunications, Consumer electronics, Computers and office machinery, Other ICT.[1] The *fractional counts*

[1] IPC codes for individual groups: Telecommunications: G01S, G08C, G09C, H01P, H01Q, H01S3/ (025, 043, 063, 067, 085, 0933, 0941, 103, 133, 18, 19, 25), H1S5, H03B, H03C, H03D, H03H, H03M, H04B, H04J, H04K, H04L, H04M, H04Q; Consumer electronics: G11B, H03F, H03G, H03J, H04H, H04N, H04R, H04S; Computers and office machinery: B07C, B41J, B41K, G02F, G03G, G05F, G06, G07, G09G, G10L, G11C, H03K, H03L; Other ICT: G01B, G01C, G01D, G01F, G01G, G01H, G01J, G01K, G01L, G01M, G01N, G01P,

approach has been applied in case of applications referring to more than one technology class.

Assigning patents to countries: Regarding the assigning patents to countries, there are two common methodologies (OECD, 2008a): it is possible to refer to either the declared country of residence of the inventor(s) ('inventor criterion') of a patent, or to that of the applicant(s) ('applicant criterion'). Several applicants could hold rights on a patent application, and they would have legal title to the patent once it is granted. In the same way, several inventors could have taken part in the development process of the invention, and be listed in the patent application. A fractional count is applied in order to assign patents to countries in cases where several inventors (or applicants) with different countries of residence have to be considered for the same application. In general, the choice of the criterion depends on the perspective from which innovative capability is being investigated. Thus, as our analysis focuses on international patenting, we count the number of inventions according to the applicant criterion to construct variable $IntApp_{ijt}$. However, in order to in order to compute the total number of a country's inventions, i.e. its inventive capacity, we apply the inventor criterion. This approach corresponds to $ICTinv_{it}$ and $ICTinv_{jt}$ in (1).

Identifying countries in which an innovation is protected: Each patent application that has been identified in step one has been linked to all the subsequent filings to any extent referring to the application which represented the first request of protection of the invention. At this point, pair of countries were formed by linking the country of applicant of the priority applications, on one side, and the country of the patent office to which the subsequent application have been submitted, on the other side. To each pair of countries the number of applications has been assigned, grouped along with the year of subsequent filing.

To compute patent-based indicators used in the current study, we use the European Patent Office (EPO) Worldwide Patent Statistical Database (known as the PATSTAT database). This database provides a worldwide coverage of patent applications submitted to around 180

G01R, G01V, G01W, G02B6, G05B, G08G, G09B, H01B11, H01J (11/, 13/, 15/, 17/, 19/, 21/, 23/, 25/, 27/, 29/, 31/, 33/, 40/, 41/, 43/, 45/), H01L.

Patent Offices in the world. The present analysis is based on indicators built by extracting and elaborating patent application data from the April 2012 release of the PATSTAT database, taking into account patent applications filed to all Patent Offices included in PATSTAT. The time period taken into account covers from January 1st, 1990 to December 31st, 2007.

Data coming from PATSTAT are elaborated through a series of methodological steps, starting with those consolidated in literature (de Rassenfosse, Dernis, Guellec, Picci, & van Pottelsberghe de la Potterie, 2011; Picci, 2010; Turlea et al., 2011) to deal with some remaining criticalities, mainly related to the process of exchange of information among patent offices, which affects patent data. First, as the needed variables are intended to provide measure of the inventive capability of countries, rather than of the productivity of patent offices, the subset of 'priority patent applications' is initially taken into account, to avoid double counting and the limitation coming from considering granted patents. The year is assigned along with the information coming with the filing date given when the application is first filed at a patent office by an applicant seeking patent. Second, to the extent of the present analysis the issue of missing information is in fact still relevant, when it comes to identify the country of residence of applicants (or inventors), and several methodological steps are followed in order to collect missing country information from other records related to the patent application, and to proxy it with that of the country where the application has been filed only as a last resort. A detailed description of the methodology can be found in de Rassenfosse, Dernis, Guellec, et al. (2011).

Explanatory variables

A set of other indicators are used to explain the drivers of international patenting. The size of the economy has been represented by the GDP in current US$ provided by World Bank data for the period covered. To the same extent, data on net inflows of foreign direct investment in current US$ came from the same source.[2] Additional characteristics related to geographical and cultural proximity, instead, are built upon data coming from the CEPII bilateral trade data (Head et al., 2010), and allow to take into account whether a pair of countries is sharing or not a common language, and to how much their geographical

[2] Available online at: http://data.worldbank.org/indicator/BX.KLT.DINV.CD.WD (last accessed on January 31st, 2012)

distance accounts for. As mentioned above, the total number of a country's ICT inventions, i.e. $ICTinv_{it}$ and $ICTinv_{jt}$, were constructed using patent data by applying the inventor criterion.

Considering the issue of patent harmonization, which reflects the problem of high costs and barriers to IP protection in a number of countries (D. Guellec & Van Pottelsberghe de la Potterie, 2002; van Pottelsberghe, 2009), we control for a country membership in the PCT. PCT_{jt} variable accounts for country's j number of years of participation into the PCT framework. The date of enforcement of the PCT in each of the countries involved in the analysis has been considered. The WIPO indicates the full date of accession and of entrance into force for each of the contracting parties, which were 20 in 1978, then grown to 30 in 1980 and 45 in 1990 to reach 108 in 2000 and to be nowadays 144 (Argentina and Iran signed in 1970, but the participation does not result enforced yet).[3]

4. Empirical findings

Our analysis of international patenting in ICT, proceeds in the following steps. First, we analyse bilateral links between countries from which international patent applications originate and countries to whose patent offices they are directed. Second, we report the results of regressions estimating the models specified in section 2. Relevant descriptive statistics together with pair-wise correlations between variables used in the current study, which provide additional insights into the subject of our analysis, are reported in a technical annex.

Sources and destinations of international ICT patents

According to **Table 1**, between 1990 and 2007, there were 1.8 million international ICT patent applications. The majority of these applications (70%) originated from only six countries and were filed to one of nine major patent offices. In this group of patent offices, the US Patent and Trademark Office (USPTO), Japanese Patent Office (JPO) and the European Patent Office (EPO) are the main destinations of international patent

[3] Source: WIPO; available at: http://www.wipo.int/treaties/en/statistics/details.jsp?treaty_id=6) (last accessed Jan.26th, 2012).

applications.[4]

Regarding the strength of bilateral links, we can observe that Japanese applicants account for an important share of international patent applications.[5] Their main points of interest with respect to seeking protection for inventions include the USPTO, EPO and, interestingly, the Chinese Patent Office. Second in terms of the number of international ICT patent filings are US applicants who seek for protection mainly in the EPO and the Japan. Also patent applications of Korean origins represent a significant share of international patenting activity. In comparison, European applicants, mainly from Germany and France or UK, occupy relatively lower positions.

[4] It must be noted that the EPO does not issue a European patents, as this right still resides in the competency of national patent offices. Hence, this analysis does not allow making any conclusions with respect to the European countries in which foreign applicants seek patent protection through the EPO applicatins.

[5] Japan is a world super-power in patenting. In 2009, the JPO is reported to have issued almost 348600 patents, majority with domestic origins (http://www.japan-patents.com/japan_patent_application.html). As a result of this patenting prowess Japanese patent applications represented almost 50% of the global total from 2000 to 2004, according to the Derwent World Patents Index. Japanese patenting predominance lies in three major industry sectors: Chemicals & Materials, Electrical & Electronic, and Engineering. Patent data available in the PATSTAT database used in this study confirms these trends, and shows that the JPO received in 2007 about 339000 applications against the almost 305000 received by the USPTO. The high performance in terms of patent application already present in the 1990s is explained by taking into consideration several factors, among which the firms' strategic behavior, the gradual expansion of technology fields covered by patent protection and, lastly, revisions of the Japanese Patent Law since its enforcement in 1953, supporting pro-patent policies on firm's innovation (Motohashi, 2003).

Table 1: International ICT patent applications by country of applicant and the designated patent office, top 20 country pairs, total for 1990-2007

Rank	Country of applicant	Designated patent office	Total number of ICT patent applications	% in total
1	JP	USPTO	329856	18%
2	JP	EPO	98533	5%
3	US	EPO	92077	5%
4	KR	USPTO	83361	5%
5	JP	Chinese PO	82427	5%
6	US	JPO	58024	3%
7	JP	German PO	54520	3%
8	JP	Korean PO	52634	3%
9	DE	EPO	47723	3%
10	DE	USPTO	43201	2%
11	DE	USPTO	43201	2%
12	US	Chinese PO	40927	2%
13	TW	USPTO	40832	2%
14	US	German PO	38211	2%
15	US	Canadian PO	33910	2%
16	KR	Chinese PO	32636	2%
17	KR	JPO	29915	2%
18	JP	Taiwanese PO	27443	2%
19	FR	EPO	26369	1%
20	US	UK PO	24734	1%
Sum of ICT patent applications for 20 top country pairs			1302135	70%
Sum of ICT patent applications for all country pairs (2782)			1822839	100%

Fractional counting according to the applicant criterion. Sum for 1990-2007.

Source: Own calculations based on PATSTAT Database, 2012

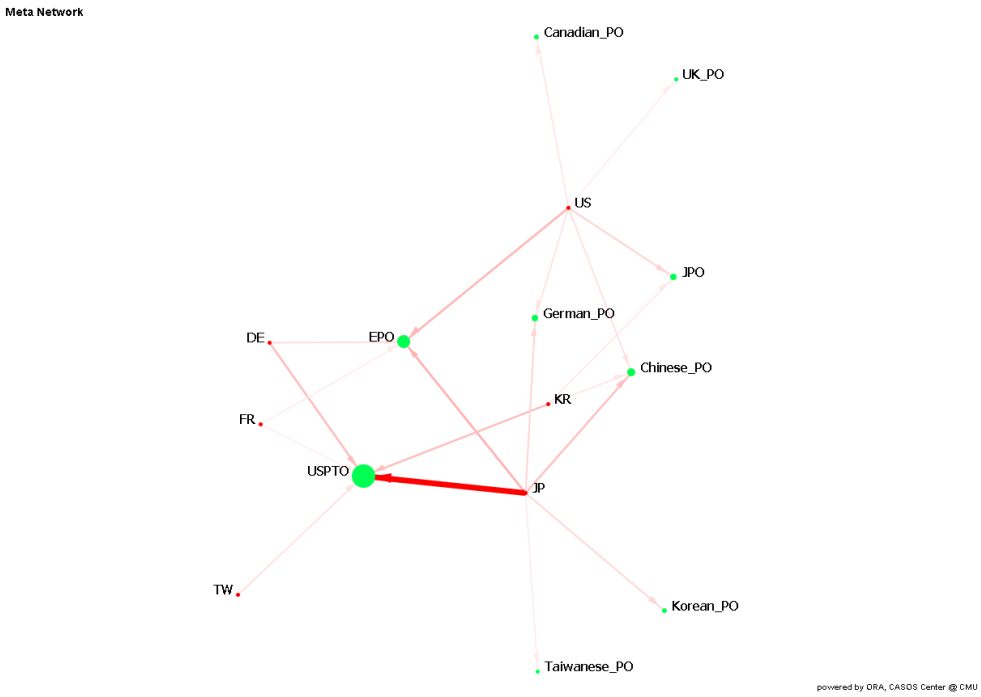
A visual representation of cross-border patenting activities delivers some additional insights. **Figure 1** represents a network of applicants and patent offices which they designate, i.e. market in which they want to obtain protection for their inventions. The graph is based on the figures reported in **Table 1**. The size of links is related to the total number of applications submitted by applicants from one country, and the nodes representing designated patent offices are weighted by the total number of foreign patent applications received.

According to this illustration, due to their patenting activity and strategy, Japanese applicants occupy a central position in this network. As already mentioned, they do not only

account for the largest number of international patent applications, but also seek for protection in the largest number of patent offices. Considering that Japanese applicants file patent applications in major Asian patent offices as well as in the USPTO and European Patent Offices, it can be seen that Japanese patenting activity goes beyond any regional boundaries. Out of the group of countries that account for the largest number of international patent applications only US applicants show similar patenting strategies. At the same time, applicants from Europe or other Asian countries tend to concentrate on a smaller number of patent offices and fewer regions. Thus, German or French applicants apply for patent protection mainly in other European countries and the US, whereas Taiwanese or Korean applicants seek for protection either in other Asian countries or the US.

The differences in international patenting noted above are quite striking, considering the global character of competition in the ICT, on the one hand. On the other hand, they indicate that applicants from different countries follow different patenting strategies in spite of being active in the same industry. The results presented here reveal also the geographical patterns of competition that ICT firms face. In particular, the important role of the USPTO clearly shows that the US is one of the markets where the competition in the ICT sector is the toughest.

Figure 1: Network of international ICT patent applications by country of applicant and the designated patent office



Fractional counting according to the applicant criterion. Sum for 1990-2007.

Source: Own calculations based on PATSTAT Database, 2012

The determinants of international patenting in ICT

To estimate the relationship between the propensity to file international patents and the set of explanatory variables defined in (1) we run two OLS regressions with country and year control effects. The first regression is on a basic model where we control for geographic and cultural proximity between countries and their economic size. In the second specification, we also include variables capturing the role of inventive capacity of both countries and the level of FDI investment and the length of PCT membership of country *j*, i.e. a country in which patent protection is sought for. The results of the regressions of are reported in Table 2.

The coefficients of the standard gravity model, i.e. geographic and cultural distance and the economy size of both countries have the expected signs and are significant. The interpretation of these findings is straightforward. Whereas the cost of seeking for patent protection increases with geographical distance, it decreases considerably with cultural

proximity. The latter one is not only important when an applicant applies for a patent, but is likely to play an even more important role when a patent needs to be enforced. This is related to the fact that patent application fees are only a small fraction of the overall cost of active protection of inventions, i.e. including litigation costs.

Regarding the size of economy of country of origin and country of destination, it is highly relevant as a driver of international patenting. Although relatively obvious, this finding needs to be considered in a broader context. The demand for international patent protection is strongly related to the global rise of the knowledge economy. One implication of this development is the fact that, over the last years, technology and knowledge have become increasingly definable and tradable goods. The possibility to sell technology rather than final goods across the borders increased (Arora et al., 2001; WIPO, 2012). A confirmation of this development is clearly visible in the increasing trend in the commercialization of IP and the resulting emergence of a market for IP, and more specifically a market in patents (Arora et al., 2001; Kanwar & Evenson, 2003). In addition, organizations other than businesses have become aware of the value of their IP and new institutions have emerged to facilitate the creation and commercialization of IP across the countries (Greenhalgh & Rogers, 2007). These trends have lead to an increase in the size of the global market for technology and technologically advanced products and, as a result, spurred the growth in the demand for IPR protection at home and overseas.

Turning to the full model, we conclude that the level of FDI in-flows to country *j* is not relevant. In contrast, the innovation capacity of both countries, measured by the total number of ICT inventions, is an important facilitator of international patenting. There are at least two reasons that can explain this. The first one relates to the fact that the innovation capacity of an applicant's country and the second to the country in which an applicant seeks for patent protection. Considering the inventive capacity of an applicant's country, it simply reflects the availability of inventions for which there may be demand on the global market. The implication of this is straightforward: the higher the production of invention in a country, the more knowledge and technology it has to offer to the rest of the world. Obviously, owners interested in transferring or exploiting their intellectual property abroad are also interested in having their assets protected in countries in which they do business. In contrast, the relationship between international patenting and the inventive capacity of a country whose IP protection is sought for is more complex. Intuitively, the level of

innovation capacity of the destination country reflects its availability of technology and know-how, which might be either complementary or competitive to the invention for which protection is being sought for. Regarding the technological complementarity, technology transfer is justified if a country has the capability to either accumulate or complement the technology. This is related to the fact that technology transfer involves usually more than just the transfer of the knowledge covered by patents (Arora, 1995). Alternatively, as noted by Furman (2002), the level of GDP also reflects a country's ability to transform its knowledge stock into economic development. Thus, the invention and/or absorptive capacity of a country and/or transferred know-how are complementary to the codified knowledge covered by patents. Regarding the issue of technological competition, the availability of know-how in a country to which technology is transferred is also a sign of the country's ability to copy the technology. In either case, i.e. technological complementarity or competition, drawing boundaries of the transferred IP is critical for retaining the rents, once the technology evolves and is commercially exploited.

Table 2: Drivers of international patenting in ICT

	$LogIntApp_{ijt}$	$LogIntApp_{ijt}$
Common Language	0.70 ***	0.76 ***
Log Distance$_{i,j}$	-0.29 ***	-0.24 ***
Log GDP$_{i,t}$	0.61 ***	0.30 ***
Log GDP$_{j,t}$	0.35 ***	0.38 ***
Log FDI$_{j,t}$		0.03
Log ICT Inv$_{i,t}$		0.42 ***
Log ICT Inv$_{j,t}$		0.23 ***
PCT		-0.01 *
Constant	-22.83	-17.86
N	14479	11316
R^2	0.64	0.69

Significance levels: * = .90, ** = .95, *** = .99. Year and country dummies included.

Source: Own calculations based on PATSTAT Database, 2010

The last observation concerns the length of PCT membership of country j. We find that being a member of the PCT does not play a major role in the decisions of non-resident applicants to seek for patent protection in foreign countries. The reason behind is that the PCT procedure is more likely to be used by either applicants residing in relatively smaller countries or that PCT applications are submitted to smaller countries, as compared to direct

patent applications. This interpretation is suggested by the findings reported in Table 1, where we can see that the majority of international patent applications originate from relatively large countries, on the one hand, and are designated to the patent offices of the largest global economies, on the other hand.

5. Conclusions

The surge in international trade and globalization of economic activity, together with the rise of the knowledge economy, has raised interest in IP protection both within national borders and across countries. Firms active in knowledge-intensive industries, such as the ICT sector, do business at the global level and, hence, also require IP protection outside their home locations. However, the strong incentives to protect inventions and technologies in many countries are weakened by the complexity, cost and redundancy of applying for patent protection in multiple national patent offices. In this paper, in order to better understand applicants' motivations in seeking protection in foreign markets, we address the issue of international patenting in ICT.

Considering the global character of the ICT industry, we find that applicants from different regions follow various patenting strategies. Whereas only Japanese and US applicants seek protection in the majority of industrialised countries, IP owners from European and other Asian countries follow regional rather than global patenting policies. The high level of patent submissions to the USPTO and to the EPO confirms the relatively high attractiveness of the US and Europe as foreign markets for ICT products and technologies. However, in the case of the latter, the interest of foreign applicants is likely to be limited to only a few countries, as European patents are issued by national patent office and not the EPO, i.e. the patents granted by the EPO are a bundle of national patents.

Regarding the major drivers of international patenting in ICT, our study shows that it is either the potential benefit of having secured revenues from relevant markets or the availability of potential competitors who are able to copy an invention or both that motivate owners of IP to file patent applications in foreign countries. Moreover, despite the availability of patenting procedures that facilitate patenting in multiple countries, such as the PCT, businesses make little use of them and prefer direct patent filings to a selected number of national offices.

The findings imply that a successful international patenting strategy should involve an assessment and selection of countries and patent offices whose protection is vital to a firm's success. This assessment should be based on the issue of the availability of technological complementary and/or competitive assets in a country. A result of this assessment is a portfolio composed of countries ranked according to their importance with respect to the protection of a firm's intellectual capital.

Annex

Table 3: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
$IntApp_{ijt}$	17579	103.6941	773.6979	0.0188	24587.92
$GDP_{i,t}$	15965	1.28E+12	2.28E+12	1.89E+08	1.41E+13
$GDP_{j,t}$	15902	1.41E+12	2.53E+12	1.17E+09	1.41E+13
$FDI_{j,t}$	13484	29961.41	52636.43	-31670.39	321276
ICT $Inv_{i,t}$	17368	7257.379	22391.33	0	132392.9
ICT $Inv_{j,t}$	16542	7969.587	22482.73	0	132392.9
PCT	15111	21.58097	8.188783	0	29

Table 4: Descriptive statistics

	$IntApp_{ijt}$	$GDP_{i,t}$	$GDP_{j,t}$	$FDI_{j,t}$	ICT $Inv_{i,t}$	ICT $Inv_{j,t}$	PCT
$IntApp_{ijt}$	1						
$GDP_{i,t}$	0.1504*	1					
$GDP_{j,t}$	0.1355*	-0.2479*	1				
$FDI_{j,t}$	0.0940*	-0.1422*	0.6951*	1			
ICT $Inv_{i,t}$	0.1954*	0.8397*	-0.2448*	-0.1409*	1		
ICT $Inv_{j,t}$	0.1302*	-0.2482*	0.8148*	0.4707*	-0.2322*	1	
PCT	0.0476*	-0.1710*	0.4872*	0.3498*	-0.1574*	0.5412*	1

Significance levels: * = .95

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Abstract
We study the drivers of international patent applications in ICT technologies by non-residents. We construct bilateral measures of foreign patent applications for all countries active as both a source of patents and a destination of applications filed between 1990 and 2007 to any patent office in the world. Despite the global character of the ICT industry, applicants from different regions follow different patenting strategies, only Japanese and US applicants are exceptionally active in seeking for patent protection in the majority of world markets. Applying a gravity model to explain the determinants of seeking patent protection in foreign markets, we find that economic and inventive capacity of a country attracts foreign patent applications.

Keywords: IPR protection, patenting strategies, international patenting, ICT, gravity model
JEL classification: D8, F2, O30, O31, O57

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